Minnesota Commercial Flower Growers Association Bulletin

Serving the Floriculture Industry in the Upper Midwest

IN THIS ISSUE

January, 1995 Volume 44, Number 1

ASEXUAL PROPAGATION OF BEDDING PLANTS

John Erwin
Department of Horticultural Science
University of Minnesota

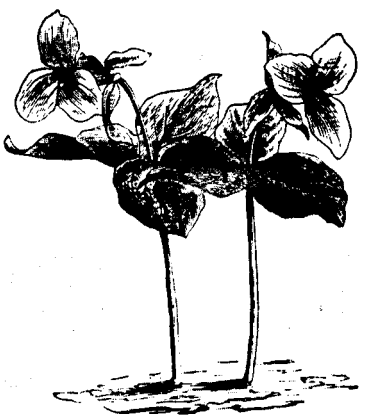
Asexual propagation is defined as the 'propagation of a plant via dissection'. Asexual propagation does not involve sex. Therefore, the original plant is not altered genetically in any way.

In contrast to asexual propagation, sexual propagation creates a unique individual that is not genetically identical to either parent. Plants have sex via pollination of flowers which results in the production of seed. Each seed is an individual; it is genetically distinct. Through progressive breeding, 'true' lines can be developed. 'True' lines result from regular selection of plants for uniformity. The results of this process is 'nearly' isogenic or similar genetic composition among seed.

The bedding plant industry has been clearly moving towards development of isogenic lines on traditionally asexually propagated plants. 'Seed geraniums', 'seed New Guinea impatiens', 'seed tuberous begonias' and recent developments to produce seed propagated fuchsia are all examples of this. The two primary reasons for this are 1) stock plants are not necessary and 2) seeds lend themselves to the plug and/or new seed-based technologies.

Application of Asexual and Sexual Propagation

Asexual propagation is used in the bedding plant industry to produce species in which isogenic seed lines cannot and/or have not been developed. In addition, crops which produce sterile flowers, such as holly, are propagated via asexual propagation.



Asexual propagation is possible because plant tissue has the capacity to regenerate any part of a plant from any piece of tissue.

Asexual propagation is also important to the fruit industry, where production of crops which do not produce viable seeds such as bananas, figs, oranges or grapes is important. Lastly, crops which have an extended juvenile period before flowering, such as trees and shrubs, are often propagated asexually.

Advantages and disadvantages of asexual versus sexual propagation are shown in Table 1. The primary reasons for asexually propagating a plant are:

1) new varieties can be introduced immediately rather than after an extended period of time as isogenic lines are developed,
2) plants in which isogenic lines have been difficult to develop can still be propagated,
3) plants will typically flower sooner when asexually propagated versus sexually propagated.

Types of Asexual Propagation

Five types of asexual propagation are common: cuttings, division, grafting and/or budding, air layering and tissue culture.

Asexual propagation is possible because plant tissue has the capacity to regenerate any part of a plant from any piece of tissue. In other words, a plant cell has the ability to develop into a root, stem, leaf or flower.

Five types of asexual propagation are common: cuttings, division, grafting and/or budding, air layering and tissue culture. The advantages, disadvantages and types of crops which are typically propagated using each technique are discussed below.

Cuttings

Propagation of new plants from 'cuttings' is the most common method of asexual propagation in the bedding plant industry.

Propagation of new plants from 'cuttings' is the most common method of asexual propagation in the bedding plant industry. A cutting consists of a stem segment, leaves and an apical meristem. Cuttings are collected periodically from 'stock plants'. Cuttings are then placed under mist to restrict water loss to enable the cutting to produce roots prior to dehydrating. Frequently a rooting hormone (indol-butyric acid (IBA)) is applied to the base of a cutting in a talc or liquid form. IBA is a compound which simulates auxin, a plant growth regulator which encourages rooting.

Cutting propagation is used extensively to produce bedding plants which are of higher value on a per plant basis. Typically, plants produced from cuttings are grown as a pot or basket crop rather than in a bedding plant flat. Bedding plants propagated from cuttings include zonal geraniums, New Guinea and double impatiens, hanging basket crops and vining or patio crops.

Division

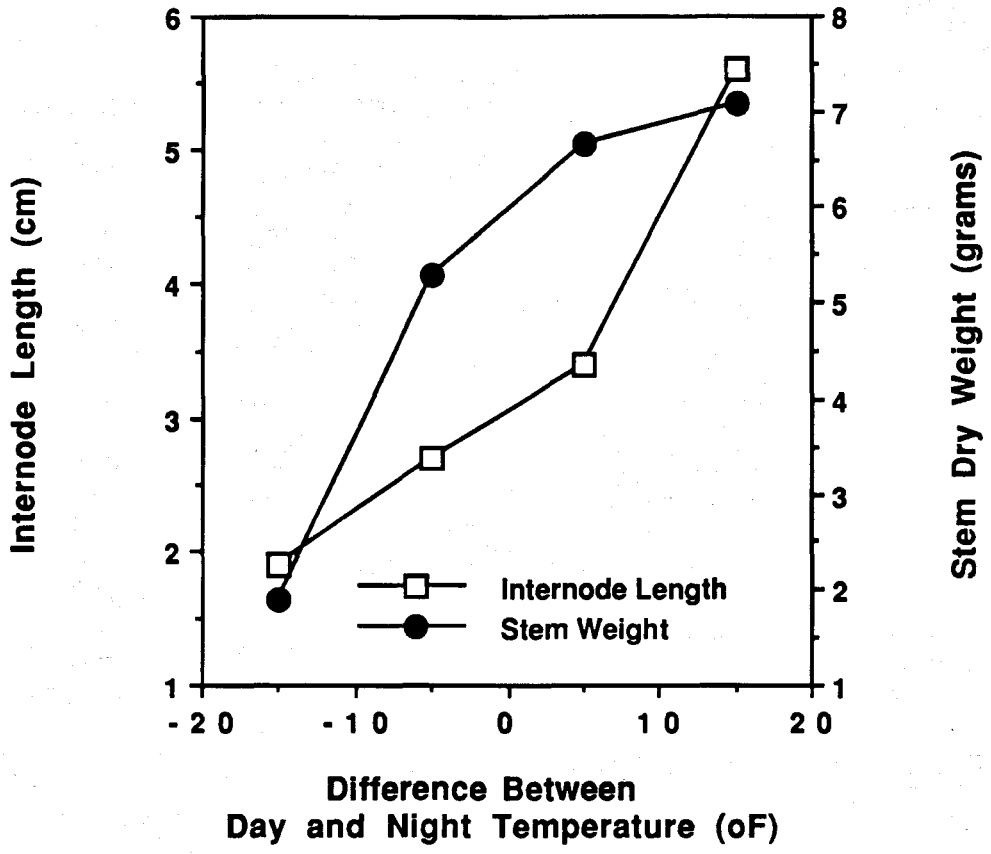
Asexual propagation through division is typically used for perennial plant species which survive winters via root system hardiness. Division involves the propagation of plants by separation of a crown or roots into individual propagules which have roots and a shoot tip (or the ability to pro-

Table 1. *Advantages and disadvantages of sexual and asexual propagation.*

	Asexual	Sexual
1) Genetic uniformity	identical to parents	usually not identical to parents except through apomixis
2) Juvenile stage	none	time varies with species
3) Total production time	less than sexual	usually more than asexual
4) Disease transmission	more common than sexual	less common than asexual
5) Rapid regeneration	possible through tissue culture	possible only with species with high seed numbers
6) Propagation of sterile or seedless plant materials	possible	impossible
7) Loss of plant vigor	can occur over time	not typical
8) Mutations	possible	possible

Propagation of new plants from 'cuttings' is the most common method of asexual propagation in the bedding plant industry.

Figure 1. *The effect of the difference between day and night temperature (day temp. - night temp.) on New Guinea impatiens internode length and stem dry weight.*



duce a shoot tip). Division is usually the slowest and/or least prolific method of propagation.

Because of the expense associated with plants that require division for propagation, only higher value bedding plants are propagated in this fashion. Flowering perennials and ground covers are commercially propagated through division. In addition, division is used to propagate tuberous crops such as tuberous begonias, dahlias and caladiums. Strawberries and raspberries are also propagated through division as opposed to seed propagated to reduce the time necessary to produce fruit from a plant. Hardy water plants are also propagated through division.

Grafting and/or Budding

Grafting is the 'art of joining parts of plants together in such a manner that they will unite and continue their growth as one plant'. Asexual propagation of bedding plants through grafting is not typical. In the past, *Gypsophila* (double flowering forms) and tree peonies were propagated through grafting. Although many bedding plants can be grafted, propagation through grafting offers no advantages and is expensive.

Layering

Layering is the propagation method by which adventitious roots are caused to form on a stem while it is still attached to the plant. Layering is most beneficial to propagate difficult to root species. Layering is commercially used to propagate vining crops and/or ground covers in the bedding plant industry. In particular, some species of *Nepeta*, *Sedum*, *Veronica* and *Thymus* were, and still are propagated through layering.

Tissue Culture

Propagation of bedding plants through tissue culture is in the beginning stages. Commercial propagation of gerbera, hosta, hemerocallis and liatris has been successful. However, the cost of tissue cul-

Grafting is the 'art of joining parts of plants together in such a manner that they will unite and continue their growth as one plant'.

Layering is the propagation method by which adventitious roots are caused to form on a stem while it is still attached to the plant.

Propagation of bedding plants through tissue culture is in the beginning stages.

tured materials can be prohibitive. Two of the greatest benefits of tissue culture are 1) its use in development of virus indexed plant material and 2) rapid initial regeneration of an individual plant into a population.

Leaf unfolding rate is dependent on the average daily temperature which plants are grown under, preferably from 50-77°F for most crops.

Stock Plant Management

Stock plants are grown to produce cuttings, or vegetative tissue, used to propagate new plants. The productivity of a stock plant is directly related to the leaf unfolding rate of a plant. The faster the leaf unfolding rate, the more frequently cuttings can be harvested.

Leaf unfolding rate is dependent on the average daily temperature which plants are grown under, preferably from 50-77°F for most crops. Leaf unfolding rate usually decreases when temperatures exceed 76°F with many plant species (Figure 1). Remember that on a sunny day leaf temperature can be 5-8°F warmer than the air temperature. Therefore, leaf unfolding rate is regularly slowed during the warmer periods of the year because plant temperatures exceed 76-78°F. Either cool or shade to reduce temperature if possible during warm periods of the year to increase leaf unfolding rate.

Total daily light affects stock plant vigor.

Flowering on stock plants is not desirable since vegetative and not reproductive tissue is desired. Plant effort should be spent on cutting production (leaf and stem) and not flower development. Flowers should be either removed mechanically or chemically. Mechanically remove flowers early in development.

Ethephon, or Florel, can be used to abort flowers early in development and/or increase branching on stock plants. Application of florel will have the side effect of reducing leaf area slightly. Dr. Peter Konjoian has conducted a significant amount of research on using florel for hanging basket production. Florel effectively eliminated flowering and increased branching early in development. Flowering occurred normally on most crops no earlier than 30 days after the last growth regulator application.

An ideal cutting is approximately 3-4 inches long and has 3-5 leaves.

Total daily light affects stock plant vigor. Supplemental lighting of stock plants during low light periods of the year increases stock plant productivity, cutting quality and the degree which cuttings root.

Table 2. *Expected cutting yield per plant of zonal geranium stock plants planted at different times of the year. As an example, a stock plant which produces a maximum of 50 cuttings will be used.*

Month	Yield
June	50 cuttings (100%)
July	45 cuttings (90%)
August	40 cuttings (80%)
September	33 cuttings (65%)
October	25 cuttings (50%)
January	10 cuttings (20%)

Nutritionally stressed stock plants produce nutritionally stressed cuttings. Stock plants should be nutrient tested regularly to insure that plants are healthy. Both soil and tissue tests should be conducted.

Cutting Quality

A cutting should 'snap' from the stock plant. Remember, cuttings are most turgid in the morning. Do not take cuttings during the afternoon.

An ideal cutting is approximately 3-4 inches long and has 3-5 leaves. The calibre of a cutting, internode lengths on a cutting and stem weight are primarily dependent on the difference between day and night temperature (DIF). Specifically, stem calibre, internode length and stem weight increase as DIF increases (Figure 1). Cutting quality is highest when plant day and night temperatures are 76 and 68°F, respectively, with many species.

Light intensity interacts with temperature to affect cutting quality. Light intensity affects the weight of a cutting. Cutting and in particular stem weight is associated with the 'rootability' of a cutting. Light intensity does not affect leaf unfolding rate-average daily temperature controls leaf unfolding rate.

In general, the lower the light intensity, the cooler the temperature stock plants should be grown at to maintain high quality cuttings. High temperatures in conjunction with low light decreases cutting quality. The reason for the drop in cutting quality at higher temperatures is that high leaf unfolding rates in conjunction which low light levels result in cuttings with thin stems and low overall dry weight. Maintain light intensities ranging from 200-600 µmol $m^{-2}s^{-1}$ during the day on stock plants.

Rooting Cuttings

Factors which affect the ability of cuttings to root include 1) the condition of the stock plant, 2) cutting tissue age, 3) presence or absence of rooting hormone, 4) degree of dehydration of the cutting, 5) shoot and medium temperature, 6) medium structure and pH, 7) the light environment in the propagation environment and 8) the presence or absence of disease.

1) The ability of a cutting to root is directly related to the vigor of the stock plant. Factors which increase stock plant vigor, such as supplemental lighting and adequate nutrition affect the vigor of a cutting and subsequent rooting. For instance, root number increased 130% when the stock plants received 500 footcandles supplemental lighting compared to natural daylight only on zonal geranium cuttings harvested in March (Nilsen, 1976).

2) In general, the most rapid and complete rooting occurs on cuttings which originate 4-6 leaves from a actively growing meristem. In other words, tissue which is finished or almost finished elongating but is not too old. Not only does older tissue root more slowly, if at all, but branching is usually decreased on older tissue versus younger tissue.

3) Application of rooting hormone can result in earlier an/or more complete rooting in many species. In general, rooting hormone is most beneficial when applied to difficult to root species. For instance, IBA has no effect on the easy to root *Clematis* x *hybrida* cv 'Gypsy Queen' but increases rooting on the difficult to root cultivar 'Jackmani' (Erwin and Schwarze, 1992).

   Overapplication of rooting hormone can burn the base of a cutting. Bedding plants require lower rates of IBA than woody plant materials. The more tender the cutting, the less hormone is needed.

4) It is essential that cuttings do not dry out. Plant tissue is most turgid, or filled with water, immediately after sunrise. Take cuttings first thing in the morning to take advantage of this. Shade cuttings and wrap them in a moist piece of newspaper until they can either be placed in the propagation area or in a holding cooler. Do not hold cuttings for more than 3 days in the cooler.

   Spray cuttings with a wetting agent immediately after placing them in the propagation area. Wetting agents help limit water loss from the cutting immediately after placing them in a sunlight environment by coating the leaf more completely with water. The propagation area should be shaded (usually saran) to limit high light intensity early in development. Often shading can be removed after the first week.

5) Temperatures should be maintained between 70-78°F medium and air temperature depending on the crop. Rooting is best when the medium temperature is the same or slightly higher than the air temperature. Cooler or warmer temperatures will delay rooting and will often increase root rot at the base of the cutting. Warmer temperatures can also encourage the spread of bacterial diseases among cuttings.

6) The propagation medium should allow for good aeration. Heavy media with poor aeration will delay rooting and encourage root rot. For this reason, soilless medium should be used. Soilless media are generally sterile and have good aeration. Do not propagate in soil or sand based media as the potential for pathogens is much greater and aeration is reduced compared to soilless media.

   Different species have different pH optima for rooting. Many species have an optimal media pH for rooting of 5.8-6.5. In contrast, some plants such as clematis appear to have an optimal pH for rooting of 7.0-8.0. Make sure media pH are in the recommended levels prior to 'sticking' cuttings.

7) Cuttings should receive bright but not direct light. Ideally, light intensity should be maintained at 500-1500 foot candles. More or less light may stress cuttings and reduce rooting. Some species can be rooted at higher light intensities after the first week.

8) Any disease on a cutting can reduce rooting. Some diseases, such as *Botrytis*, may only affect an individual leaf on a cutting. In contrast, bacterial diseases, such as *Erwinia*, will destroy the entire cutting rapidly.

   When cuttings are under mist for prolonged periods of time, nutrients may leach from the leaves. When this occurs, leaf color becomes more chlorotic or yellow. Fertilize cuttings

The ability of a cutting to root is directly related to the vigor of the stock plant.

Application of rooting hormone can result in earlier an/or more complete rooting in many species.

Temperatures should be maintained between 70-78°F medium and air temperature depending on the crop.

Cuttings should receive bright but not direct light.

through the mist line using 100-300 ppm N and K no more than once per week if cuttings require an extended period of time to root.

Common Diseases in Asexual Propagation

Botrytis is a common problem during propagation. The most effective method of control is through removal of all debris in the propagation area. Spray applications are also effective. Lastly, good air movement is critical. When cuttings are spaced tightly, the risk of *Botrytis* increases substantially.

Botrytis is a common problem during propagation.

Bacterial soft rot (*Erwinia*) is a common problem in unsanitary rooting environments. Poor air movement, warm temperatures and splashing water contribute to the spread of the disease throughout the propagation area. If soft rot is found, destroy infected plants and isolate healthy plants from the infected region as best as possible. Remember that bacterial soft rot can be spread by hand contact. Therefore, sterilize hands periodically when touching plants if 'soft rot' is evident.

Bacterial soft rot (*Erwinia*) is a common problem in unsanitary rooting environments.

Pythium and *Rhizoctonia* are root rot diseases which can attack cuttings during propagation. Symptoms usually move from the root system up and are characterized by 1) wilting of the cutting and 2) a black soft region on the lower part of the stem.

Post Rooting Care

Following rooting, great care must be taken not to stress the rooted cuttings. Typically, rooted cuttings are potted and placed in an open greenhouse. During the first 3-5 days, it is critical that cuttings not be exposed to direct sunlight. In addition, strong fertilizer and/or acid solutions should not be applied over the cuttings. When strong fertilizer or acid solutions are applied overhead young leaf distortion can occur.

Following rooting, great care must be taken not to stress the rooted cuttings.

Specific Crop Recommendations

Specific recommendations will only be discussed for geraniums, New Guinea and double impatiens, and basket and patio crops. Tables 3 and 4 give specific recommendation techniques for propagation techniques for perennials and ground cover crops.

Pelargonium

The most common geraniums propagated asexually is the zonal geranium and regal geraniums.

Table 3. *Perennials which are commonly propagated via asexual propagation and the recommended propagation technique.*

Genus	Preferred Method of Commercial Asexual Propagation
Achillea	Cutting
Aegopodium	Division
Ajuga	Division
Alchemilla	Division
Artemisia	Cutting
Aruncus	Cutting
Aster	Cutting
Astilbe	Division
Boltonia	Cutting
Brunnera	Division
Convallaria	Division
Dianthus	Cutting
Dicentra	Division
Galium	Cutting
Geranium	Division
Gypsophila	Cutting
Hemerocallis	Division
Heuchera	Division
Hosta	Division
Iris	Division
Lamium	Cutting
Lavender	Cutting
Ligularia	Division
Lythrum	Cutting
Mentha	Cutting
Monarda	Cutting
Nepeta	Cutting
Peony	Division
Penstemon	Cutting
Phalaris	Division
Phlox	Cutting
Physostegia	Cutting
Polemonium	Division
Salvia	Cutting
Sedum	Cutting
Sempervivum	Division
Tiarella	Division
Teucrium	Cutting
Tradescantia	Division
Thymus	Cutting
Veronica	Cutting
Viola	Division

The zonal geranium, or *Pelargonium* x *hortorum* is a hybrid between *P. inquinans* and *P. zonale*. Geraniums have been vegetatively propagated for centuries. Sexual propagation of geraniums is a recent development.

Geranium stock plants are started at different times of the year. The earlier the stock plants are started, the more cuttings a stock plant will produce over the life of the plant. Regal geranium stock plants should be started 1 month earlier than zonal geranium stock plants. Table 2 shows the expected yield per zonal geranium stock plant planted at different times of the year.

Zonal geraniums are day neutral plants. In other words, daylength does not affect flower initiation in zonal geraniums. In contrast, regal geraniums are long day plants. In other words, days longer than nights will promote flowering in regals. Days shorter than nights will promote vegetative growth. During summer months, temperatures are so warm that flowering is generally inhibited in regal geraniums. However, if stock plants receive light pollution or night interruption lighting during cooler periods of the year, flowering may be promoted. Therefore, during cooler periods of the year, pulling shade cloth to limit photoperiod length will aide in maintaining vegetative plants.

Plant cuttings in a 6-8" pot. Final spacing should be approximately 1 plant per ft² on plants started in June. Pinch plants 3-5 weeks after planting when the stem is approximately 4-6 inches in height. There should be at least 4-5 internodes on the mother stem when plants are pinched. Pinch plants by removing the uppermost two to three leaves.

Pinch as needed after the initial pinch. Harvest or take cuttings periodically when at least 3-5 leaves can be taken with a cutting and still leave 3-4 nodes on the stock plant from which new lateral shoots can develop. Apply florel to stock plants to increase branching and decrease leaf size. Do not apply florel after October 15th as cutting quality can decrease substantially under low light conditions during the winter.

Table 4. *Common methods of asexual propagation techniques of ground cover crops. Preferred time of propagation is also included.*

Genus	Common Name	Time	Asexual Method
Aegopogium	Goutweed	Spring or Fall	Division
Ajuga	Bugleweed	Spring or Fall	Division
Cerastium	Snow-in-Summer	Spring or Fall	Cuttings Division
Convallaria	Lily-of-the-Valley	Early Spring	Division
Epimedium	Barrenwort	Spring	Division
Euonymus	Wintercreeper	June to August	Cuttings Root Layering
Hedera	English Ivy	July to September	Cuttings Root Layering
Hemerocallis	Daylily	Spring of Fall	Division Tissue Culture
Hosta	Hosta	Spring or Fall	Division Tissue Culture
Iberis	Candytuft	June to August	Cuttings Division
Lonicera	Japanese Honeysuckle	Summer	Cuttings Division
Pachysandra	Japanese Spurge	Late June	Cuttings Division
Sedum	Stonecrop	Midsummer	Cuttings Division
Thymus	Creeping Thyme	Spring or Fall	Division Cuttings
Vinca	Periwinkle	Spring	Division Cuttings

Geranium stock plants are started at different times of the year. The earlier the stock plants are started, the more cuttings a stock plant will produce over the life of the plant.

Zonal geraniums are day neutral plants. In other words, daylength does not affect flower initiation in zonal geraniums.

Harvest or take cuttings periodically when at least 3-5 leaves can be taken with a cutting and still leave 3-4 nodes on the stock plant from which new lateral shoots can develop.

The most critical factor in producing geraniums from cuttings is maintaining disease-free stock plants.

The most critical factor in producing geraniums from cuttings is maintaining disease-free stock plants. Bacterial diseases of geraniums, such as *Xanthomonas*, have resulted in enormous problems throughout the geranium industry after propagation. Often the symptoms of infection are not evident until spring of the following year, when temperatures increase in the spring. Symptoms may appear in the greenhouse or in a consumers flower bed.

It is essential that stock plant cuttings be purchased from a reputable source who supplies cultured virus indexed stock plants. Remember to have cuttings tested for *Xanthomonas* regardless of the cutting source! Universities within each state often have a disease testing laboratory which can test for *Xanthomonas*. In addition, new diagnostic kits allow growers to use immunoassay techniques with ease at a significantly reduced price.

Even if cuttings are confirmed 'disease-free', you should grow the crop as if there may be some infected plants.

Even if cuttings are confirmed 'disease-free', you should grow the crop as if there may be some infected plants. In other words, plants should be grown to limit potential spread of disease among plants:

1) Limit splashing of water between plants. The best way to do this is to simply water plants using trickle irrigation versus overhead watering.
2) Clean benches with a 10% chlorox solution prior to placing stock plants on them.
3) Dip all tools used for pruning or taking cuttings in alcohol or chlorox (10% solution) regularly.

Grow stock plants at temperatures between 65 and 76oF.

Grow stock plants at temperatures between 65 and 76oF. The warmer the average daily temperature when day and night temperature fall within this temperature range the more rapid the rate of leaf unfolding. Therefore, cutting production increases as average daily temperature increased up to 76oF of zonal geraniums (Figure 2).

In general, zonal geranium cuttings do not need rooting hormone to promote rooting. Cuttings taken at the appropriate time in development and placed on a bench with bottom heat (70-74oF) will rot in 7 to 10 days. However, if cuttings are taken when tissue is 'harder' rooting hormone may be necessary. If rooting hormone is applied, use liquid formulations at low rates or talc (Hormex #1).

Regal geraniums, in general, require rooting hormone application for rooting to occur. It is especially important that medium temperature be warm (72-75oF) to promote rooting in Regals. Under ideal conditions rooting should occur in 10-14 days with Regal geraniums.

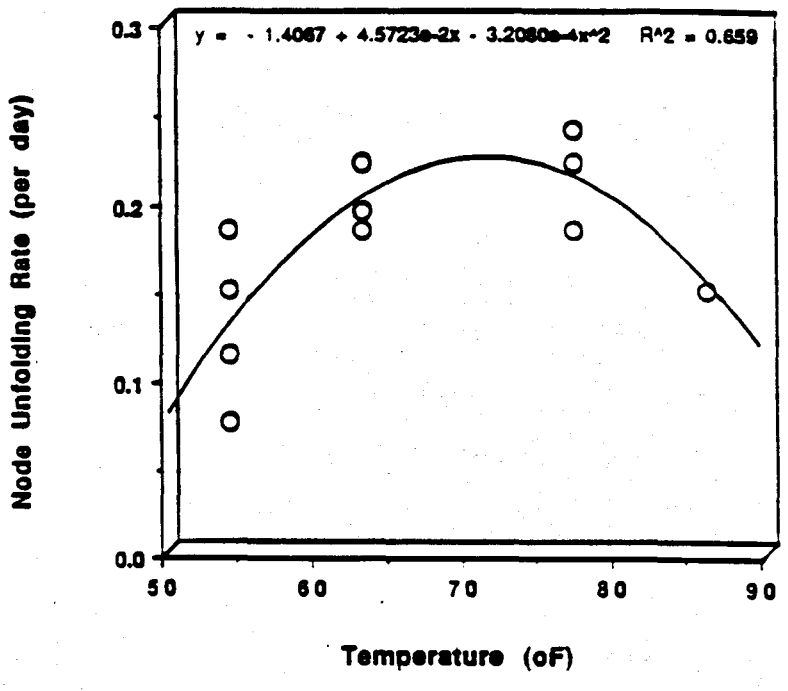


Figure 2. *The effect of average daily temperature on zonal geranium leaf (node) unfolding rate.*

New Guinea and double impatiens

New Guinea impatiens. New Guinea and double impatiens propagation is similar to that of *Pelargonium.* As with geranium propagation, disease control is critical. New Guinea and double impatiens are extremely susceptible to tomato spotted wilt virus (TSWV). As with *Xanthomonas*, symptoms of TSWV can occur long after propagation. For this reason, purchase new stock plant cuttings each year. Do not keep cuttings from year to year! Symptoms of TSWV vary but often include:

1) stunting of shoot tips,
2) distortion of young leaves,
3) spotting of leaves and
4) blackening of the leaf mid-vein on variegated cultivars.

It is very important to understand that a plant may not express TSWV symptoms even if it is infected. Therefore, do not assume that a crop is not infected simply because it is not showing symptoms Test a random sample of newly arrived plants for the presence of TSWV. Also, test stock plants regularly for TSWV to make sure that you are not propagating the virus as well as New Guinea impatiens!

The virus is spread by the western flower thrips. The best method of TSWV control is to simply eliminate western flower thrips from your greenhouse. Eliminate plant material which may harbor western flower thrips in a greenhouse prior to placing a New Guinea impatiens crop in the greenhouse. Do not regularly move new materials which may be carrying the western flower thrips through or into greenhouses which contain New Guinea impatiens.

New Guinea impatiens grow optimally when temperatures range from 68-78°F. Warmer or cooler temperatures substantially reduce growth. Stock plants should be grown with a 76°F day temperature and a 68°F night temperature. This temperature regime will encourage leaf unfolding, partitioning of carbon to the stem, wide stem calibre and internode elongation. If internodes are too long, reduce the difference between the day and night temperature, i.e. grow plants at constant 72°F.

New Guinea impatiens plants branch freely. Therefore, florel application does not, in general, promote branching in New Guinea impatiens.

New Guinea impatiens cuttings do not require application of IBA. Medium temperature should be maintained at 70-74°F during the rooting period.

New Guinea and double impatiens propagation is similar to that of *Pelargonium.*

New Guinea impatiens grow optimally when temperatures range from 68-78°F.

New Guinea impatiens cuttings do not require application of IBA.

Table 5. *Cultural information on common spring hanging basket and container crops.*

Plant	Planting Time	Plants per Pot	Number and Timing of Pinches	Crop Time
Anigozanthos (Kangaroo Paw)	February through March	3-5 plants per 6" pot, 4-5 plants per 8-10" pot	No pinching necessary	10-14 wks
Achimenes hybrids	Plant rhizomes in February through April	8 per 8" pot or 6 per 6" pot	Pinch as needed to control height	10-14 wks
Abutilon 'Apricot Glow'	Mid-December to late February	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	Two, pinch at plant and 6 wks later	14-16 wks
Argeranthemum frutescens (Marguerite daisy)	Mid-December to late February	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	One, pinch 2 wks after planting	12-14 wks
Astericus 'Gold Coin'	Mid-December to late February	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	Soft pinch at planting, otherwise to maintain form	12-14 wks

Table 5. *Continued.*

Plant	Planting Time	Plants per Pot	Number and Timing of Pinches	Crop Time
Bacopa 'Snowflake' (Sutera diffusus)	January to February	3-4 plants per 8-10" pot, 1-2 plant per 4-6" pot	One, soft pinch when planting	12-14 wks
Begonia 'Looking Glass'	Mid-December to late February	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	One, pinch 2 wks after planting	12-14 wks
Brachycome melanocarp 'Pink Swirl'	Early December to early February	3-4 plants per 8-10" pot, 2 plants per 6" pot, 1 plant per 4" pot	One, pinch 4 wks after planting liners	14-16 wks
Brachycome hybrid 'Ultra'	January to April	3-4 plants per 8-10" pot, 2 plants per 6" pot, 1 plant per 4" pot	Unnecessary	8-12 wks
Caladium hybrids	February to April	3-5 no. 1 tubers per 5-6" pot	Unnecessary	8-12 wks
Dianthus caryophylus cv 'Sweetheart Cascade' (Carnation)	January to February	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	One, pinch 2 wks after planting	14-16 wks
Coreopsis grandiflora cv 'Sundancer'	Early January to late February	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	One, pinch 2 wks after planting	12-14 wks
Diascia cv 'Ruby Field' and 'Elliot's Field'	Mid-December to late February	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	One, pinch 2 wks after planting	14-16 wks
Diphlandenia	Mid-October to mid-December	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	At least twice, at planting and again 6 wks later	20-25 wks
Evolvulous 'Hawaiian Blue Eyes'	Mid-December to late February	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	Two, pinch 2 wks after planting and again 4 wks later	14-16 wks
Fuchsia x hybrida cvs	Mid-January to late February	3-4 plants per 8-10" pot	One or two, pinch twice on early plantings, once on late plantings	12-16 wks

Table 5. *Continued.*

Plant	Planting Time	Plants per Pot	Number and Timing of Pinches	Crop Time
Geranium cv 'Sugar Plum'	Mid-December to late February	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	One, soft pinch 2 wks after planting	10-14 wks
Helichrysum bracteatum 'Golden Beauty'	January to March	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	One, pinch 2 wks after planting	12-14 wks
Ivy Geranium	Mid-December to late February	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	Two to three times, do not pinch after March 15	12-16 wks
Lantana camara	Mid-December to February	4-5 plants per 8-10" pot, 1 plant per 4" pot	Pinch as needed for stem elongation	12-16 wks
Lobelia cv 'Royal Jewels'	Mid-December to late February	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	Two, pinch 2 wks after planting and again when needed	14-16 wks
Lotus	Mid-December to late February	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	Two, pinch 2 wks after planting and again 5 wks later	14-16 wks
Lysimachia cv 'Golden Globes'	Mid-December to late February	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	One, pinch 2 wks after planting	12-14 wks
New Guinea Impatiens	Mid-January to Early April	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	Unnecessary	8-12 wks
Osteopermum cv 'Sparkler'	January to February	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	Two, pinch 2 wks after planting and again 5 wks later	12-14 wks
Passiflora	December to March	3-4 plants per 8-10" pot	As needed	15-18 wks
Pseuderant hemum 'Amethyst Star'	Mid-April to mid-June for late summer finish	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	Two, pinch 2 wks after planting and again 6 wks later	14-18 wks
Ranunculus asiaticus	Mid-February to early March	3-5 tuberous roots per 5-6" pot	Unnecessary	10-12 wks
Scaevola aemula cv 'Blue Wonder'	January to April	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	Two to three times, 2 wks after planting and again until 4 wks before finish	12-14 wks

Table 5. *Continued.*

Plant	Planting Time	Plants per Pot	Number and Timing of Pinches	Crop Time
Scaevola cv 'Petite'	Mid-December to late February	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	One, pinch at planting	14-16 wks
Sunlovers Supertunias	Mid-February to late March	3-4 plants per 8-10" pot, 1 plant per 4-6" pot	One, pinch 2 wks after planting	5-6 wks

One of the most common problems with New Guinea impatiens production is micronutrient toxicity.

Care should be taken to insure that the medium pH is not 6.0 or higher. Cuttings should root in 7 to 21 days.

One of the most common problems with New Guinea impatiens production is micronutrient toxicity. Micronutrient toxicity can occur when the medium pH is below 5.8 and micronutrients have been added to the rooting medium. Do not fertilize New Guinea impatiens since they are very sensitive to excess fertilizer.

Double impatiens. Treat double impatiens as New Guinea impatiens. As with New Guinea impatiens, double impatiens are very susceptible to TSWV. Thrips control is more difficult with this crop compared to New Guinea impatiens since the flowers provide a protective environment for thrips.

Many hanging basket crops are asexually propagated.

Hanging Basket and Patio Container Crops

Many hanging basket crops are asexually propagated. Since many hanging basket crops are long day plant, i.e. long days promote flowering, cuttings are often propagated from stock plants grown under short day conditions.

The number of cuttings and planting times for plugs or cuttings into baskets or patio containers depends, to a great extent, on pot size and when a crop is to be marketed. Some general guidelines for a variety of hanging basket crops and patio crops are shown in Table 5.

Conclusions

The primary concern when asexually propagating plant material should be bacterial and viral disease control. Regular monitoring for these diseases and roguing of plants throughout the propagation industry and within your greenhouse will greatly decrease the spread of these diseases throughout the U.S. and into the consumers yard. When in doubt - test!

References

Nilsen, J.H. 1976. Effects of irradiation of the motherplants on rooting of *Pelargonium* (*hortorum*) cuttings. Acta Horticulturae 64:65-69.

Erwin, J.E., and D. Schwarze 1992. Factors affecting clematis rooting. Minnesota Commercial Flower Growers Association Bulletin 41(4):1-7.

The primary concern when asexually propagating plant material should be bacterial and viral disease control.