

# VASCULAR CONNECTION IN STEM-ROOT TRANSITION REGION OF IN VITRO GRAPES (*Vitis* sp. 'Valiant')

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Incomplete vascular connection between roots and shoots of various in vitro plantlets has been implicated in the poor survival of acclimatized plants. In this study, the anatomy of the stem-root transition region of in vitro and acclimatized grape (*Vitis* sp. 'Valiant') were studied by light microscopy. Grape plantlets were micropropagated on MS medium supplemented with 5  $\mu$ M BAP for multiplication and 0.4  $\mu$ M NAA for rooting. Roots developed directly from stem tissues after two weeks in rooting media. Subsequently in vitro rooted plantlets were acclimatized in the greenhouse for 6 weeks. Continuation of xylem vessels were observed in the stem-root transition region of the in vitro plantlets. No anatomical differences were observed in stem-root transition regions between direct rooting in vitro and those acclimatized ex-vitro for 6 weeks. Therefore, poor survival of in vitro propagated grapes are not due to incomplete vascular connection between roots and shoots.

## 654 (PS 4)

### TISSUE AND PROTOPLAST CULTURE OF *SOLANUM OCHRANTHUM*.

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*Solanum ochroanthum*, a woody non-tuber bearing species, may possess genes for insect and disease resistance which could be useful in solanaceous crop improvement. Methods for tissue and protoplast culture of *S. ochroanthum* were developed as part of an ongoing project to improve tomato and potato using wild relatives and in vitro techniques such as somatic hybridization. For protoplast experiments, axenic shoot tip cuttings were propagated on medium containing MS salts, Staba vitamins, 100 mg l<sup>-1</sup> casein, 3% sucrose and 0.6% activated charcoal (OM) or medium containing MS salts and vitamins, 100 mg l<sup>-1</sup> casein and 2% sucrose (TPM). Plants grown on OM were significantly taller, had higher root dry weight and gave protoplasts with higher average plating efficiency than plants grown on TPM. Leaf protoplasts from 5 week old plants cultured in medium with high Ca<sup>2+</sup> and myoinositol generally had higher percent viability and plating efficiency than protoplasts grown in a modified Kao and Michayluk 8p medium.

## 655 (PS 4)

### IN VITRO ROOTING AND ACCLIMATIZATION OF *PRUNUS SEROTINA* USING PACLOBUTRAZOL

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Paclobutrazol (PBZ), a triazole growth retardant known to harden various species to stress, was incorporated into the in vitro rooting medium of *Prunus serotina* var. *virens* at rates of 0.00, 0.15, 0.30, and 0.60 mg/L with and without 1.0 mg/L indolebutyric acid (IBA). PBZ significantly reduced shoot growth in vitro but increased/improved the quality and coloration. Although not significant, the roots appeared shorter, thicker, more numerous, and percentage was higher. The percent water loss from detached leaves of in vitro plantlets was significantly reduced by PBZ and IBA. Four weeks after transfer to the greenhouse, survival was significantly improved by PBZ, IBA, and the combination. The incorporation of PBZ in vitro better enables plantlets of *Prunus serotina* var. *virens* to withstand the stresses associated with acclimatization and offers the potential to benefit other more difficult-to-acclimatize plant species.

## 656 (PS 4)

### MICROPROPAGATION OF COCOYAM (*XANTHOSOMA SAGITTIFOLIUM* (L.) SCHOTT)

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Studies were conducted to improve the establishment medium and to induce multiple shoot formation for mass production of cocoyam. The addition of 1 mg/l isopentenyladenine to the basal B5 liquid medium enhanced regeneration and plantlet establishment. Multiple shoot formation was favored by 10 mg/l benzylaminopurine in the basal medium. Furthermore, the multiplication rate could be increased and the

micropropagation process enhanced when 4 week old plantlets, rather than 6 week old, were used to induce multiple shoot formation. These results confirmed earlier findings on the effects of sequential application of growth regulators on organogenesis in cocoyam cultures. The impact of these results for mass propagation of this crop is discussed.

## 657 (PS 4)

### VARIETAL DIFFERENCES IN CALLUS AND SHOOT FORMATION OF *PELARGONIUM* SPP.

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Before attempting transformation of *Pelargonium* spp., it is necessary to develop procedures for shoot regeneration under selective conditions (kanamycin resistance). Leaf disks of various cultivars of regal, zonal, ivy-leaved, and scented pelargoniums were compared for shoot regenerability and phenolic production. Disks were cultured on MS medium supplemented with 10.7  $\mu$ M NAA and 8.9  $\mu$ M BA. After three weeks in darkness, each disk was transferred to MS with 0.89  $\mu$ M BA and evaluated for proportion of disks with callus, extent of disk development, and the rate and intensity of phenolic halo production. Phenolic production was not correlated with shoot regeneration ability. Regal pelargoniums had low phenolic production, while ivy-leaved pelargoniums had both the highest phenolic production and callus formation. Shoot regeneration from leaf disks was inhibited on media containing 100  $\mu$ g/ml kanamycin.

## 658 (PS 4)

### INFLUENCE OF PECAN SOMATIC EMBRYO MORPHOLOGY ON CONVERSION INTO PLANTLETS

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It has previously been shown that the induction medium influences embryogenesis and embryo morphology in pecan (*Carya illinoensis*). The objective of this study was to evaluate the effect of embryo morphology on germination and conversion into plants. Pecan somatic embryos induced on modified WPM with NAA or 2,4-D were categorized into three classes according to morphology: embryos with evident apex and well formed cotyledons; embryos with weak or no apex, with or without distinct cotyledons; and abnormal embryos. Embryos were given conversion-enhancing treatments which included cold treatment for eight weeks, followed by desiccation for five days. The embryos were then transferred to modified WPM with 10mg/l silver nitrate and 5mg/l gibberellic acid. The conversion of embryos was rated based on presence of leaflets and roots. Embryos germinated in all three classes. Conversion was markedly affected by embryo morphology; higher conversion rates were obtained with embryos which more closely resembled the zygotic morphology.

## 659 (PS 4)

### CYTOKININS AND DONOR PLANTS AFFECT REGENERATIVE CAPACITY OF AMERICAN ELM LEAVES

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Adventitious shoots can be regenerated from leaf explants of American elm (*Ulmus americana* L.), but the effects of cytokinins and donor plants were unknown. The goal of this study was to examine factors that influence regenerative capacity of American elm leaves. Excised leaves from 2-year-old seedlings were surface sterilized, and 1 cm<sup>2</sup> sections were taken from the midrib portion of the leaves. Three to six seedlings were used as donor plants in various experiments. Zero, 7.5, 15, or 22.5  $\mu$ M of benzyladenine (BA), thidiazuron (TDZ), kinetin, zeatin, or 2iP were added to Driver Kunyuki Walnut (DKW) medium. Basal medium (DKW and Murashige and Skoog [MS]) effects on shoot regeneration were also examined. Leaves placed on media with BA or TDZ formed adventitious shoots, with TDZ inducing the highest percentage of regeneration. The donor plant also affected the efficiency of shoot regeneration, with certain seedlings having 1.5 to 7 times more explants forming shoots compared to others. Leaf explants from donor plants with the highest regenerative capacity had a higher percentage of regeneration on DKW than MS medium. Explants from productive donor plants should be placed on DKW medium supplemented with TDZ to improve shoot regeneration efficiency from American elm leaves.



660 (PS 4)

INFLUENCE OF AGAR AND AMMONIUM NITRATE ON TISSUE NITROGEN, CULTURE GROWTH, AND VITRIFICATION

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Shoot tips of *Amelanchier* were grown on Murashige & Skoog (MS) or Woody Plant (WP) medium containing 4.4  $\mu$ M benzyladenine and 4, 6 or 8% Difco Bactoagar. Increasing agar concentration reduced culture fresh weight, dry weight, and vitrification, but increased tissue nitrate concentrations. The number of shoots produced per culture was unaffected by agar concentration. Overall, response to agar additions was similar for shoots on both WP and MS salts, although the magnitude of the response may have differed. *Amelanchier* shoots cultured on WP medium containing 4% agar and 10.5, 15.5, 20.9 or 25.5 mM nitrate showed a linear increase in culture fresh weight, culture dry weight, number of shoots per culture and number of vitrified shoots per culture as medium nitrate concentration increased. Nitrate and total nitrogen content of explants also increased linearly with increasing medium nitrate concentration. Although vitrification has been previously ascribed to elevated ammonium concentrations in culture media, it is possible that elevated medium and tissue nitrate levels may also play a role in vitrification.

661 (PS 4)

PLANT REGENERATION AND TRANSFORMATION IN *COREOPSIS LANCEOLATA*

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Leaf discs of *Coreopsis lanceolata*, when cultured on Murashige and Skoog (MS) medium supplemented with 10  $\mu$ M benzyladenine (BA) and 1  $\mu$ M naphthaleneacetic acid (NAA), produced shoots in four weeks. Shoots were often induced on the marginal tissues of the leaf discs without callus formation. The frequency and the number of shoots induced per leaf disc varied slightly when growth regulator combinations of 0.5-40  $\mu$ M BA and 0-2  $\mu$ M NAA were tested. Most shoots produced roots on the same regeneration medium after formation of 3 to 5 leaves. The rooted plants were established in soil within 3 months from initial culture. For genetic transformation, leaf discs were infected with *Agrobacterium tumefaciens* Strain LBA 4404 carrying both kanamycin resistance and  $\beta$ -glucuronidase (*GUS*) genes. Shoots were induced from these leaf discs on the regeneration medium containing 250 mg/liter kanamycin. The histochemical assay showed that the regenerated shoots were *GUS* positive.

662 (PS 4)

MICROPROPAGATION OF GAS PLANT (*DICTAMNUS ALBUS*)

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Gas plant is an elegant ornamental which blooms in early summer. It is commonly propagated by seed which is limited by a complex dormancy. Micropropagation was investigated as an alternative method for efficiently propagating gas plant. Rapidly growing two node stem pieces were taken from mature greenhouse grown plants, surface sterilized and placed in MS medium with 1  $\mu$ M benzyladenine (BA). Shoot multiplication was studied using in vitro derived four node explants cultured on MS media containing BA at 0, 1, 5, or 10  $\mu$ M. Explants cultured on BA at 1 and 5  $\mu$ M averaged 3.9 and 5.6 shoots per explant respectively and a mean yield of 2.7 and 2.5 shoots greater than 2 cm in length. Explants cultured at 10  $\mu$ M produced 5.7 shoots per explant with only 0.8 shoots greater than 2 cm in length. Microcuttings failed to root in vitro even in the presence of indolebutyric acid (IBA). Microcuttings directly stuck ex-vitro in a peat-lite medium root at 90% with 1.9 roots per cutting.

663 (PS 4)

THE DEVELOPMENT OF TRICHOME-LIKE STRUCTURES IN CALLUS CULTURES OF SPRING BEAUTY (*CLAYTONIA VIRGINICA*)

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Tissue cultures were initiated in spring beauty from petal or sepal tissue on a MS medium. Using a factorial combination of naphthaleneacetic acid and kinetin, only sepal tissue responded to form callus. Callus proliferating on the 5.4  $\mu$ M NAA + 9.3  $\mu$ M KN would periodically form shoots at a low frequency. After six months in culture on this medium, trichome-like structures developed along the surface of the proliferating callus. Two types of trichome-like structures were observed in these cultures. One type was a multibranched structure and the second type was linear with a glandular tip. The trichome-like structures were assimilated as the callus mass increased in size. In addition, the cells in the callus just below the surface were pigmented. The pink pigment was visually similar to the natural petal coloration. Leaf, sepal and petal tissue did not produce obvious trichomes on greenhouse grown plants.

664 (PS 4)

ADVENTITIOUS SHOOT FORMATION IN EASTERN REDBUD (*CERCIS CANADENSIS*)

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Adventitious shoot induction was studied using isolated parts of in vitro grown seedlings of Eastern redbud. The explants studied included the cotyledon node (with or without cotyledons), cotyledon, hypocotyl, epicotyl, root, nodal stem and seedling leaf pieces. Explants were treated with a factorial combination of benzylaminopurine (BAP) and thidiazuron (TDZ) on DKW medium. Cultures of Eastern redbud produced a low frequency of adventitious shoot formation for all explants tested except for explants with the cotyledonary node. These explants produced 5.9 shoots per culture after treatment with 10  $\mu$ M BAP + 1  $\mu$ M TDZ. However, shoots produced on a medium containing TDZ failed to elongate. Many of the TDZ induced shoots were abnormal and distorted. Shoot elongation was promoted by transferring explants to a medium with BAP alone.

665 (PS 4)

THE PRODUCTION OF HAPLOID CALLUS FROM ANther CULTURE IN SWEET CHERRY (*PRUNUS AVIUM* L.)

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Map development in Angiosperm tree crops is hampered by the lack of suitable mapping populations and the time and space required to grow large progeny populations. An alternate strategy for developing a linkage map for sweet cherry using haploids derived from anther culture as the progeny populations is being developed. The genetic markers will be RAPDs which segregate 1:1 among the progeny. Our initial objective is to obtain haploid microspore-derived callus cultures from sweet cherry. Two sweet cherry cultivars, Bing and Emperor Francis, were chosen which are heterozygous for *Pgi*, and *Pgi* and 6-*Pgd*-1, respectively. Branches were forced in the laboratory. When the microspores reached the uninucleate stage the anthers were plated on medium containing 4.4  $\mu$ M BA and 4.5  $\mu$ M 2,4-D. After  $\approx$ 50 days, callus which burst from the anther was placed on Woody Plant Medium supplemented with 1  $\mu$ M 2,4-D and 3  $\mu$ M 2iP and routinely transferred. To date, 64 callus cultures from Emperor Francis exhibited only one allele each from *Pgi* and 6-*Pgd*-1 and are therefore putative haploids. Four callus cultures of Bing exhibited only one allele for *Pgi*.



# THIAZURON-MEDIATED INDUCTION OF ADVENTITIOUS SHOOTS IN SWEETPOTATO

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An efficient two stage protocol has been developed for inducing adventitious shoots from the *in vitro* - derived petiole pieces of sweetpotato. Petiole sections (0.5 - 1 cm) were taken from apical portions of the sweetpotato cultivar USDA PI 318846-3. Explants were placed horizontally on the first stage media (Murashige and Skoog basal medium + 2,4 -D, 0.2 mg/L) for 2 to 4 days, then transferred to the second stage and kept vertically with the base of the petiole inside the medium. During the second stage, the MS medium was supplemented with various levels (0.0 mg/L to 4 mg/L) of thidiazuron (TDZ). High and rapid shoot regeneration was observed on TDZ, 0.2 mg/L (36% of explants developing shoots in 15 days), resulting in a maximum of 80% regeneration frequency by 30 days of incubation. Increasing concentrations of TDZ (> 0.4 mg/L) lowered the shoot and root regeneration. Although the shoots grew slightly slow on the MS + TDZ (0.2 mg/L) medium, they rooted normally and grew vigorously when transferred to a hormone-free medium. Whole plants were acclimatized by culturing in sterile soil and then grown in the green house. This protocol may be suitable for genetic transformation studies using *Agrobacterium* vector and particle bombardment approaches.

## 667 (PS 4)

# IDENTIFICATION OF A NEW BENZYL ADENINE COMPOUND PRODUCED DURING PETUNIA SHOOT ORGANOGENESIS

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Studies of benzyl adenine (BA) uptake and metabolism in *Petunia* leaf explants during shoot organogenesis revealed a novel BA conjugate. The new conjugate comprised up to 39% of the total pool of BA conjugates in two *petunia* lines and was associated with an increased shoot organogenic response when compared with a third *petunia* line which did not produce the conjugate. To identify the new compound, structural analysis was conducted using FAB mass spectrometry, two methods of carbohydrate analysis, UV absorption spectra and FTIR spectra. Experimental results identified the compound as 6-benzylamino-9-[O-glucopyranosyl-(1→3)-ribofuranosyl]-purine, a disaccharide conjugate of BA. Based on biological studies and similarity to other cytokinin conjugates, this disaccharide cytokinin conjugate may be part of the interconvertible pool of cytokinins active in shoot organogenesis.

## 668 (PS 5)

# EFFECT OF DIKEGULAC ON BRACT SIZE OF BOUGAINVILLEA

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Flowering of *Bougainvillea* is enhanced when liners are treated 0 and 4 weeks after transplanting and pruning with 1200 or 1600 ppm dikegulac (ATRIMMEC). Dikegulac, however, slightly to moderately reduces bract size. This study was conducted to quantify the effect of dikegulac on bract size. Rooted liners of *Bougainvillea* 'Mauna Kea' were transplanted into 2.5-liter containers (1 liner/container) on 14 April (Expt. 1) or 20 August 1991 (Expt. 2) and pruned (0 weeks). Dikegulac at 0, 400, 800, 1200, or 1600 ppm was applied at 0 and 4 weeks. Control plants were also pruned at 4 weeks. Plants were grown under full sun. In Expt. 1, 400 ppm dikegulac reduced bract size about 25%, with 800 to 1600 ppm reducing bract size about 37%. However, dikegulac had little to no effect on bract size in Expt. 2 seemingly due to cool temperatures. The mean minimum and maximum temperatures were about the same during the first six weeks of both experiments; however, the mean minimum/maximum temperatures for the remainder of Expt. 1 and 2 were 19.2°/30.4° and 10.8°/23.2°C, respectively.

## 669 (PS 5)

# RESPONSES OF ORNAMENTAL FLOWERING CABBAGE AND KALE CULTIVARS TO FOUR COMMERCIAL GROWTH RETARDANTS

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Four commercial growth retardants (B-nine, Cycocel, A-rest and Bonzi) were compared for their effectiveness in controlling the growth and development of three ornamental flowering cabbage cultivars (white, red, and pink) and two flowering ornamental kale cultivars (frizzy red

and red peacock). Two weeks after transplanting; seedlings of each cultivar were sprayed with aqueous solutions of the four commercial growth retardants. Treatments for each cultivar were arranged in a randomized complete block design with 6 replications. Plant height, plant width and dry weight were the parameters used to measure growth and development. Treatments for each cultivar were rated for head formation and color development. Results showed that all the growth retardants except for cycocel significantly affected growth and development without any effect on head formation and color development. Bonzi caused the greatest growth suppression.

## 670 (PS 5)

# COMPARISON OF TECHNOLOGIES FOR GROWTH REGULATOR APPLICATION TO ANNUALS

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Application by fixed-position mist blower (MB), air-assisted electrostatic sprayer (ES), hydraulic piston pump sprayer (PP) or hand-held compressed air sprayer (HH) was compared for growth regulator efficacy on *Petunia hybrida* 'Polo Burgundy Star' and *Tagetes erecta* 'Inca Orange'. Daminozide at 5000 mg/l (DM) or paclobutrazol at 75 mg/l (PB) was applied using PP or HH sprayers (high volume) at 200 ml/m<sup>2</sup>. ES (low volume) and MB (ultra low volume) sprayers were adjusted to provide an equivalent active ingredient of growth regulator per area. Growth of marigold was similar between the 2 growth regulators. Marigolds treated by either growth regulator averaged 92% of untreated plant height, except ES-treated plants which averaged 80%. ES-treated marigolds flowered 4 days later and had less top dry weight than plants in other treatments. Growth regulator-treated petunias averaged 90% of untreated plant height. Generally, there were few differences between petunias treated with DM or PB but the results showed some sprayer type by growth regulator interaction. Type of application was slightly more important for applying DM than PB to petunias.

## 671 (PS 5)

# RESPONSE OF 'PRIZE' AZALEA TO UNICONAZOLE APPLIED AT FOUR STAGES OF SHOOT APEX DEVELOPMENT

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Forcing azalea cultivar 'Prize' was treated with 15 or 30 mg a.i. uniconazole/liter at four stages of shoot apex development (SOD 0 = vegetative; 1 = change in shape of terminal; 2-3 = first row of floral parts originated or petals differentiated; 4 = anthers differentiated). Plant height and growth index increments increased when uniconazole was applied at a later SOD but decreased with increasing concentration. Bypass shoot number decreased quadratically with increasing concentration, but was not affected by SOD. Time to flower and flower number varied with SOD and concentration. Plants treated at SOD 0 or 1 flowered earlier and with more blooms than control plants; plants treated with 15 mg a.i. uniconazole/liter at SOD 2-3 flowered at the same time as control plants with a similar number of blooms. Plants treated with 30 mg a.i. uniconazole/liter at SOD 2-3 or at SOD 4 with either concentration flowered after control plants with fewer blooms.

## 672 (PS 5)

# PINE BARK- AND PEAT-BASED MEDIA INFLUENCE THE EFFECTS OF PACLOBUTRAZOL SPIKES ON 'CELEBRATE 2' POINSETTIAS.

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The objective of this study was to determine the influences of 8 commercial media, 4 peat-based and 4 pine bark-based, on the effects of paclobutrazol applied to the media of each plant at pinch in a spike formulation or as a drench (two weeks after pinch) to 'Celebrate 2' poinsettias. The peat-based media were Baccto Grower's Mix, Baccto High Porosity Professional, Baccto High Porosity Professional with Bacctite, and Baccto Rockwool Mix. The pine bark-based media were Metro 360, 366, 700, and 702. Paclobutrazol was applied to the media at 10 treatment combinations (0, 2, 4, 6 and 8-0.05% spikes, 1 and 2-0.2% spikes, 1 0.08% spike, and 0.25 and 0.50 mg drenches in each 15 cm pot). Spike and drench



formulations of paclobutrazol reduced plant size. Plants grown in the peat-based media were more sensitive to paclobutrazol than those grown in bark-based media. Stem length of those plants treated with paclobutrazol spikes was less than those treated with an equal amount of paclobutrazol as a drench in all media except the Rockwool Mix and Metro 702.

#### 673 (PS 5)

##### PINE BARK-AND PEAT-BASED MEDIA INFLUENCE THE EFFECTS OF PACLOBUTRAZOL AND UNICONAZOLE DRENCH ON 'GUTBIER V-14 GLORY' POINSETTIAS.

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The objective of this study was to determine the influences of 8 commercial media, 4 peat-based and 4 pine bark-based, on the effects of paclobutrazol and uniconazole applied as a media drench to 'Gutbier V-14 Glory' poinsettias. The peat-based media were Baccto Grower's Mix, Baccto High Porosity Professional, Baccto High Porosity Professional with Bacctite, and Baccto Rockwool Mix. The pine bark-based media were Metro 360, 366, 700, and 702. Paclobutrazol and uniconazole were each applied to plants grown in each media at 5 rates (0, 0.125, 0.250, 0.375, and 0.500 mg-15 cm pot<sup>-1</sup>). Paclobutrazol and uniconazole effectively reduced plant height in all media. Plants grown in the Metro products, however, tended to be larger than those grown in the Baccto products. Plants grown in the peat-based media were more sensitive to growth regulator drenches. Plants grown in Metro 360 and 366 were the least sensitive to plant growth regulator drenches compared to the Baccto media.

#### 674 (PS 5)

##### EFFECTS OF SURESTEM PLANT GROWTH MODIFIER ON STEM NUMBER, LENGTH, AND QUALITY OF HYBRID TEA ROSES GROWN IN GREENHOUSES

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SURESTEM plant growth modifier, applied in foliar sprays at 80.0 g ai/H to regrowing stems following rose stem harvest, increased Royalty variety hybrid tea rose stem number and length and improved stem quality. Stem numbers per harvest were increased in Samantha and Cardinal variety roses, but there were no changes in stem quality or stem length. For rose stems harvested on a growth cycle basis, excellent stem number increases were obtained when SURESTEM was applied about 7 days after 90% of the stems had been harvested. The best time of application was affected by temperature and light conditions in the greenhouse, by natural photoperiod in the absence of artificial lighting, and by stem harvest practices of the growers. The best time of application for plants managed on a continuous stem harvest system has not yet been determined. Commercial producers of long-stem roses are evaluating SURESTEM under an EPA Experimental Use Permit issued April 7, 1992. The EUP program and label also permits the evaluation of SURESTEM on other ornamental crops grown for cut stem production in greenhouses.

#### 675 (PS 5)

##### GROWTH RETARDATION OF *NARCISSUS TAZETTA* DURING FORCING

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Bulbs of the Chinese Sacred Lily (*Narcissus tazetta*) are forced in water about 28 days before Chinese New Year. Excessive leaf and scape length may necessitate tying to render the plants presentable. No. 1 bulbs which had been cleaned and placed in water for 2 days were treated with 10 ppm ancymidol, 50 ppm paclobutrazol, 25 ppm uniconazole, 10 ppm flurprimidol, or 100 ppm ethephon. At 70% of control plant height, ethephon-treated plants were shortest, and flowering was not delayed. Daughter bulbs were soaked in 50 ppm flurprimidol to determine the most effective stage at which to treat. Soaking the dry bulbs for 1 hour at 36°C was most effective (58% of control), but delayed flowering more than a week. Soaking the bulbs for one hour when emerging roots were 0.5 cm long was also effective (65% of control). At 11 days of forcing when emerging leaves

were 4 - 6 cm long, the entangled root systems were soaked in the retardant which was then drained off. This treatment achieved 74% of control growth. Scape lengths in all flurprimidol treatments were 60-65% of the foliage length compared to 82% for the controls.

#### 676 (PS 5)

##### EFFECT OF UNICONAZOLE RATE AND TIME OF APPLICATION ON MORPHOLOGICAL QUALITY CHARACTERISTICS OF MINIATURE POT ROSES

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Uniconazole was sprayed at 25, 50, 75 or 100 mg-liter<sup>-1</sup> on plants of *Rosa* L. 'Meirural', 'Meijikatar' and 'Meilarco' in experiments at Overton and College Station. A short cycle production schedule was used consisting of liner establishment in 11.4 cm pots, severe cut back and a final forcing period. In late summer experiments, the 25 mg-liter<sup>-1</sup> treatment reduced plant height, peduncle length and increased days to harvest by 3 days, but either increased or had little effect on the number of flowers. All cultivars were affected similarly. Higher concentrations severely reduced plant height, number of flowers, peduncle length and caused a slightly longer delay in days to harvest. Application of uniconazole to new shoots that had grown 5-7 cm long after the cut back was as effective in reducing plant height as a split application (half the full rate at each time) made when new shoots were 5-7 cm and when new shoots exhibited pea size buds. A single application at pea-bud stage was not effective in controlling height. When experiments were repeated in early spring, uniconazole had a stronger effect on plants than in the summer. Further research is needed concerning the interaction of environmental variables and uniconazole rate for optimum control of pot rose growth.

#### 677 (PS 5)

##### EFFECT OF GROWTH REGULATORS ON HEIGHT OF PENTAS

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Pentas (*P. lanceolata* Benth.) cv. Ruby Glow Red single node cuttings were grown in 15 cm pots in a glasshouse and developing laterals were pinched to one node. Plants were sprayed with chlormequat (CCC) at 0, 500, 1000, 1500, or 2000 ppm on 5, 10, or 15 days after pinching. An ancymidol (0.5 mg ai/15 cm pot) drench treatment was applied at the above 3 dates. Application date had no effect on plant height and ancymidol had minimal effect. All CCC treated plants were shorter than controls but little differences were recorded among CCC conc. Since most stem elongation occurred after the inflorescence was ca. 2 cm diam., a second experiment with similarly grown plants consisted of CCC sprays of 0, 500, 1000, 2000, or 4000 ppm applied 10 days after pinching. Additional CCC applications were made when the inflorescence was 2 cm diam. All treatments yielded plants shorter than controls which were 57 cm. Plants sprayed initially with CCC at 2000 ppm plus CCC at either 500, 1000, or 2000 ppm at the bud stage ranged from 28 to 32 cm tall, an ideal height range for 15 cm pots. CCC at 4000 ppm appeared to reduce stem turgidity and the inflorescence tended to droop at maturity.

#### 678 (PS 5)

##### HYBRID LILY RESPONSES TO DAY/NIGHT TEMPERATURE REGIMES (DIF), GROWTH RETARDANTS, AND GROWING MEDIA COMPOSITION.

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Hybrid lilies (4 oriental & 2 asiatic) species were grown in commercial potting media formulations containing various percentages of composted bark. Lilies were grown in greenhouse sections maintained at either 21°C day temperature and 15°C night temperature or 15°C day temperature and 21°C night temperature from emergence until anthesis. The growth retardants Paclobutrazol (Bonzi) and Uniconazole (Sumagic) were applied as a media drench at 0.25 mg a.i. per pot. Final height, days to flower from planting, days to flower from visible bud, and flower number were recorded for each treatment. Plant height was significantly reduced by potting media formulation, growth retardant treatment, and temperature regime. The effects of these treatments on bud number, and days to flower will also be discussed.



679 (PS 5)

# **Evaluation of Hand Held, Flat Electrode pH, Electrical Conductivity, Potassium, and Nitrate Meters**

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Cardy flat electrode pH, electrical conductivity, potassium and nitrate meters were evaluated for their application to greenhouse solution and media testing. The pH, EC, K, and  $\text{NO}_3\text{-N}$  levels in 7 recirculated nutrient solution reservoirs were monitored weekly for 8 weeks using Cardy meters and standard methods. Regression analysis of the results of the Cardy meters against those of standard methods resulted in slopes of 0.64, 0.94, 1.05 and 1.03 for pH, EC,  $\text{NO}_3\text{-N}$  and K respectively. Saturated media extract (SME) samples of a peat-based medium were diluted to provide concentrations of 10 to 200  $\text{mg liter}^{-1}$   $\text{NO}_3\text{-N}$ . The regression equation describing the relationship between the colorimetric and Cardy determinations was:  $\text{ppm NO}_3\text{-N} = 0.86 * \text{Cardy ppm NO}_3\text{-N} + 11.1$  ( $R^2=0.98$ ). In a separate experiment,  $\text{KNO}_3$  and  $\text{Ca(NO}_3)_2$  were added to a commercial peat-based medium to provide 27 to 490  $\text{mg liter}^{-1}$   $\text{NO}_3\text{-N}$  using the SME method. The regression equation describing the relationship between the colorimetric and Cardy determinations was:  $\text{ppm NO}_3\text{-N} = 1.05 * \text{Cardy ppm NO}_3\text{-N} - 2.05$  ( $R^2=0.98$ ). Chloride in the range of 0 to 1400  $\text{mg liter}^{-1}$  resulted in a 0.02  $\text{mg liter}^{-1}$  increase in  $\text{NO}_3\text{-N}$  with every 1  $\text{mg liter}^{-1}$  increase in chloride.

680 (PS 5)

# **SORPTION ISOTHERMS INDICATE THAT CALCINED CLAY AND ALUMINUM AMENDMENTS INCREASE PHOSPHATE RETENTION OF SOILLESS SUBSTRATES**

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Soilless container substrate components such as sphagnum peat moss and pine bark have very little  $\text{PO}_4$  adsorption capacity; thus, one way to reduce  $\text{PO}_4$  leaching during container production is to increase the  $\text{PO}_4$  retention of container substrates. Laboratory experiments have been conducted to create sorption isotherms at 26 C for arcillite, a calcined product of the 2:1 clays montmorillonite and illite, and a medium of 70 peat moss: 30 perlite. Thirty ml of  $\text{Ca(H}_2\text{PO}_4)_2$  solutions at rates of 0, 100, 300, and 500  $\mu\text{g P/ml}$  were added to 5  $\text{cm}^3$  samples of the test materials. Both materials were amended with aluminum at rates of 6.4 and 19.2  $\text{mg Al/cm}^3$  test material from  $\text{Al}_2(\text{SO}_4)_3$  solutions. Adsorption isotherms confirmed that unamended medium does not retain  $\text{PO}_4$  and indicated that arcillite is effective at adsorbing  $\text{PO}_4$  as it retained 1900  $\mu\text{g P/cm}^3$  test material at the 500  $\mu\text{g P/ml}$  rate. The isotherms also showed that Al amendments increase  $\text{PO}_4$  retention in both arcillite and the medium. Desorption isotherms suggested that the unamended arcillite and Al-amended medium and arcillite will continue to release low levels of  $\text{PO}_4$  for an extended period of time.

681 (PS 5)

# **EVALUATION OF PELLETIZED SEWAGE SLUDGE FERTILIZER FOR GREENHOUSE PLANTS** **Douglas Cox\***, Plant and Soil Sciences, University of Massachusetts, Amherst, MA 01003

In separate experiments 'First Lady' marigold (*Tagetes erecta* L.) and 'Selenia' New Guinea impatiens (*Impatiens* sp. hybrids) (NGI) plants in 0.5-liter pots of soilless mix were fertilized with water-soluble 20N-4.3P-16.6K (WS), controlled-release 14N-6.2P-11.6K (CR), or two types of heat-dried sewage sludge pellets (3N-1P-0.1K or 5N-1.3P-0.1K,  $\approx 3\text{mm}$  dia.) (SP). All fertilizer treatments were calculated to supply the same amount of N in each experiment. The same volume of irrigation water was applied to all plants during each experiment. Leachate was analyzed for  $\text{NH}_4\text{-N}$  and  $\text{NO}_3\text{-N}$  at regular intervals and growth was measured at the end of each experiment. SP alone reduced N leaching an average of 54% compared to WS or CR alone, but did not provide adequate nutrition for marigold; symptoms of N deficiency and reduced dry weight were the result. However, SP alone caused no such effects on NGI. Marigold growth was increased and N deficiency symptoms were prevented by partially substituting SP with WS at 25% of total N supplied. The same treatment had no effects on NGI. Combining SP and WS in this manner resulted in little or no increase in N leaching over SP alone.

682 (PS 5)

# **PHOSPHORUS LEACHING FROM POTTED POINSETTIA WITH LEACHING FRACTIONS OF 0, 0.2, AND 0.4**

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Single-pinched 'V-14 Glory' poinsettias in 15-cm diameter pots of growing medium received constant liquid fertigation with 200  $\text{mg/L}$  N from 100%  $\text{NO}_3\text{-N}$  or 60%  $\text{NO}_3\text{-N}$ :40%  $\text{NH}_4\text{-N}$ , 8 or 23  $\text{mg/L}$  P, and leaching fractions (LFs) of 0, 0.2, and 0.4 during a 13 week study. The total P applied via fertigation ranged from 43  $\text{mg}$  at 0 LF to 303  $\text{mg}$  at 0.4 LF. P leached with tap water from unplanted pots totalled 31  $\text{mg}$ . The concentration of leachate P ranged from 0.2 to 46  $\text{mg/L}$ . With 8  $\text{mg/L}$  P, leachate P decreased from a mean of 35  $\text{mg/L}$  initially to less than 4  $\text{mg/L}$  after 30 days. The percentage of the applied P in the leachate at 8  $\text{mg/L}$  P fertigation was 12% at 0.2 LF and 20% at 0.4 LF for both N sources. With 23  $\text{mg/L}$  P fertigation these losses were 24% at 0.2 LF and 41% at 0.4 LF for 60%  $\text{NO}_3\text{-N}$  plants but only 11% at 0.2 LF and 25% at 0.4 LF for 100%  $\text{NO}_3\text{-N}$  plants. Across all treatments, the P in the shoot was partitioned as follows: 31% in leaves, 42% in bracts, and 28% in stems. Although plants receiving 23  $\text{mg/L}$  P had a 41% higher P concentration in their shoots than 8  $\text{mg/L}$  P plants, there were no differences in yield between the two P levels.

683 (PS 5)

# **EFFECTS OF SUPPLEMENTAL $\text{NH}_4\text{NO}_3$ DRENCHES AND NO-LEACH PRODUCTION ON POINSETTIAS GROWN WITH CONTROLLED-RELEASE FERTILIZERS**

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Previous studies have shown that plants grown exclusively with controlled-release fertilizers (CRF) at recommended rates dramatically reduced N and P runoff but did not provide sufficient nutrients for optimum plant growth. 'Gutbier V-14 Glory' poinsettias were grown in 15-cm pots amended with CRF and drenched with 300  $\text{mg liter}^{-3}$   $\text{NH}_4\text{NO}_3$  at: 1 week; 2 weeks; 1 and 3 weeks; 1, 3, and 7 weeks; 1, 3, 7, and 11 weeks after potting. Half the plants were grown with saucers underneath the pot to allow plants to reabsorb all leachate (no-leach). Control plants remained undrenched. For plants without saucers, all drenching treatments increased bract dry weights when compared to undrenched plants. Leaf dry weight increased with all drenching treatments except for 2<sup>nd</sup> week only treatment. Plants grown without saucers had greater leaf, stem and root dry weights, but similar bract and flower dry weights when compared to plants grown with saucers. Regardless of the use of saucers, nitrogen concentration in the leaf tissue tended to increase with greater number of  $\text{NH}_4\text{NO}_3$  drenches and visual ratings were similar.

684 (PS 5)

# **PHENYLGLYOXAL INHIBITS NITRATE UPTAKE BY INTACT POINSETTIA ROOTS AND ROOT PLASMA MEMBRANE VESICLES**

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Phenylglyoxal (PGO) a chemical modifier of arginine residues inhibits nitrate ( $\text{NO}_3^-$ ) uptake by corn roots. It has been proposed that the  $\text{NO}_3^-$  uptake system in corn has essential arginyl residues in or near the  $\text{NO}_3^-$  binding site. PGO was used to evaluate  $\text{NO}_3^-$  uptake by Poinsettia roots. Inhibition of  $\text{NO}_3^-$  uptake was observed using three levels of PGO (0.25, 0.5, 1mM). Root plasma membrane vesicles were isolated and used in uptake experiments to determine if PGO was interacting with the  $\text{NO}_3^-$  uptake system located in that membrane.  $^{36}\text{ClO}_3^-$  which is a  $\text{NO}_3^-$  analog, accumulated only in the vesicles that were not treated with PGO.



# DETERMINATION OF CAUSAL RELATIONSHIP BETWEEN PHOSPHORUS AND BRACT EDGE BURN OF POINSETTIAS

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Increasing rates of triple superphosphate added to the root media have a positive correlation with bract edge burn on poinsettias (Whipker, Hammer, 1992). We have studied the effects of application of increasing rates of phosphorus supplied from multiple sources. Analysis of P content and other elements were conducted on root media and foliar samples to determine source of toxicity.

*Euphorbia pulcherrima* Willd. cultivars Dark Red Hegg and Red Sails were potted on September 8, 1992 in a root medium of peat, perlite and soil (40:40:20, v/v) mixture amended with N, K, Ca and micronutrients. Prior to potting, the root media were also amended with either .30, 2.37 or 4.75 kg P/m<sup>3</sup> of superphosphate (0-18-0) or triple superphosphate (0-46-0). Two additional treatments of 75 mg P/liter and 150 mg P/liter supplied via 75% technical grade phosphoric acid in the irrigation system were also studied. Foliar samples were analyzed for N, P, K, Mg, Ca and fluoride every two weeks after the start of short days. Root media samples were also collected and analyzed for pH, SS, NO<sub>3</sub>, NH<sub>4</sub>, P, K, Mg and Ca. Plant height, leaf dry weight and stem dry weight were measured on each sampling date as well as bract diameter and bract edge burn count at anthesis.

Media P levels increased as phosphorus rate increased for all P sources. By the second sampling date, severe toxicity symptoms developed on foliage of the 4.75 kg P/m<sup>3</sup> rate of superphosphate. This toxicity corresponded to high media P levels. Bract burn count at anthesis increased significantly at rates of 2.37 and 4.75 kg P/m<sup>3</sup> of both superphosphate and triple superphosphate. The highest incidence of bract burn (21.875 bracts burned/plant) occurred with application of 2.37 kg P/m<sup>3</sup> of triple superphosphate.

# PHOSPHORUS FERTILIZATION OF ALSTROEMERIA FOR CUT FLOWERS

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*Alstroemeria hybrid* 'Parigro Pink' divisions planted in 1 peat: 1 granulated rockwool medium were grown in a greenhouse maintained at 10 C minimum night temperature. Fertilizer solution containing 10 mM KNO<sub>3</sub>, 5 mM NH<sub>4</sub>NO<sub>3</sub>, 5 mM Ca(NO<sub>3</sub>)<sub>2</sub>, 1 mM MgSO<sub>4</sub>, 20 μM Fe, 10 μM Mn, 20 μM B, 2 μM Zn, 1.5 μM Cu, and 1.0 μM Mo, plus 0, 0.15, 0.30, 0.6, 1.2 or 2.4 mM KH<sub>2</sub>PO<sub>4</sub>, with 0 to 1.2 mM K<sub>2</sub>SO<sub>4</sub> used to balance K<sup>+</sup>, was applied at 7 to 10 day intervals. Plants were irrigated with tap water as needed between fertilizer applications. Plants supplied 2.4 mM P produced approximately 20% more total flowers and 33% more grade 1 flower stems (total length at least 80 cm, and bearing 4 or more cymes per stem) than plants supplied 1.2 mM P, and more than 4 times as many grade 1 flowers as plants supplied 0.3 mM P or less. In leaf tissue samples comprising the uppermost leaves of flowering stems, P concentration tended to increase with P supply but to decrease with time. During the period from 60 to 120 days from first harvest, tissue concentrations in the range 3.3 to 4.1 mg P / g dry wt were associated with highest yield.

# STAGE OF DEVELOPMENT AFFECTS NUTRIENT UPTAKE IN FOUR SNAPDRAGON CULTIVARS

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Nutrient uptake by *Antirrhinum majus* L. 'Apache', 'Jersey City', 'Peoria', and 'Philadelphia' was compared at three developmental stages: Stage I, vegetative to bud initiation; Stage II, bud initiation to visible bud; and Stage III, visible bud to anthesis. Significant differences in uptake occurred between one or more developmental stages for all nutrients tested (NO<sub>3</sub><sup>-</sup>, NH<sub>4</sub><sup>+</sup>, B, Ca<sup>++</sup>, Cu<sup>++</sup>, Fe<sup>++</sup>, K<sup>+</sup>, Mg<sup>++</sup>, Mn<sup>++</sup>, Mo<sup>-</sup>, P, and Zn<sup>++</sup>). Uptake of the majority of nutrients increased or remained high during Stage III. These results indicate that the current cultural practice of stopping fertilization at bud elongation should be reexamined. Differences in uptake between cultivars were found only for NO<sub>3</sub><sup>-</sup> as uptake by 'Apache' was significantly higher than uptake by 'Philadelphia'.

# Peat-based Potting Media is an Extraneous Source of Iron When Using an Iron Chelate

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The use of an iron chelate, Fe-DTPA, has been associated with an Fe toxicity disorder affecting the leaves of cutting geranium, *Pelargonium x hortorum*. In previous research Fe concentrations in medium leachates were higher than applied Fe-DTPA. The blank chelate DTPA has been shown to be an effective extractor of micronutrients from soilless media. Plants were grown in a

controlled environment chamber at 22C and 16HR photoperiod, in a peat-based medium. In experiment 1 treatments of 0, 0.2 and 2 mM DTPA were applied to the growth medium and in experiment 2 treatments of 0, 0.02 and 0.2 mM DTPA and Fe-DTPA were used. Tissue and leachates were analyzed for Fe concentrations. Leachates of experiment 1 revealed that 2 mM DTPA extracted up to 1.79 mM Fe for the first week and then decreased to 0.3 mM while 0.2 mM DTPA extracted Fe in concentrations that generally increased during the experiment to 0.3 mM. In experiment 2 leachate concentrations of Fe from the 0.02 mM DTPA and Fe-DTPA treatments were similar and increased from 0.02 mM to 0.035 mM. The 0.2 mM Fe-DTPA increased from 0.14 mM to 0.26 mM while the 0.2 mM DTPA decreased from 0.17 mM to 0.054 mM. The 0 treatment of both experiments had 0.0027 mM Fe in the leachates. The tissue analysis of experiment 1 was inconclusive. Experiment 2 revealed no differences in weight and no difference in the total amount of Fe accumulated by the plants. This indicates that the practice of using Fe-DTPA, which increases the amount of potentially available Fe, may be a causal factor in geraniums accumulating toxic levels of Fe.

# IRON DISTRIBUTION AND THE OCCURRENCE OF AN IRON PHYSIOLOGICAL DISORDER IN MARIGOLD

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The objective of this experiment was to study Fe distribution patterns in marigold (*Tagetes erecta* L., cv First Lady). Previous experiments have identified 'First Lady' as an Fe-sensitive cultivar. Plants were grown in a commercial peat-based media. Treatments consisted of 0, 17.9 and 179 μM Fe-DTPA added to a modified Hoagland's solution. In the presence of excess Fe, 'First Lady' developed a speckled pattern of chlorosis and/or necrosis of recently matured, primary leaves associated with downward leaf curl and/or cupping. Hereafter the disorder is referred to as "Bronze Speckle". Plants treated with 179 μM Fe-DTPA developed symptoms of "Bronze Speckle" with symptom severity increasing with leaf age and Fe concentration. Plants of the 0 and 17.9 μM treatments did not develop "Bronze Speckle", however Fe concentrations varied by treatment and tissue. Iron concentration in roots increased with Fe-DTPA treatment. Treatments had no effect on plant height or axillary and primary flower bud production.

# GENETIC DIVERSITY IN POPULATIONS OF NATIVE GRASSES AND FORBS IN MINNESOTA

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The Legislative Commission on Minnesota Resources initiated a program to develop a viable seed industry for the production of native grasses and forb. A part of this program is to measure the amount of genetic diversity among and between populations in Minnesota. This information will be used to develop strategies for the distribution of seed in land reclamation and for management of seed production to maintain the genetic diversity of commercial seed lots. Two grasses, *Andropogon gerardii* and *Schizachyrium scoparium*, and two forbs, *Monarda fistulosa* and *Liatris* sp., were used in this study. Genetic diversity of populations was measured using morphological traits and isozyme analysis of 30 to 50 individuals from each of the 13 to 49 populations. Thirteen enzymes systems were examined to detect polymorphisms. Isozyme polymorphisms have been detected in *Liatris* populations for PGM, MDH and ACP. No isozyme polymorphisms have been detected in grass populations. Morphological characteristics were measured in a common nursery to remove genotype x environment interactions. Variation in height, number of stems and number of inflorescences were observed within and among grass populations. *Liatris* populations varied in leaf number, width and length and shoot dry weights.

# INHERITANCE OF QUALITATIVE TRAITS IN NEW GUINEA IMPATIENS

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New Guinea impatiens have been growing in popularity as a potted, bedding and hanging basket plant. This growth has been due mainly to the development of new cultivars by commercial breeding programs. However, no one has investigated or reported the inheritance of simple Mendelian traits of economic importance.

A study of the genetics of six qualitative traits was undertaken to elucidate inheritance of these traits in New Guinea impatiens. The traits studied were flower color, flower size, leaf color, leaf vein color, leaf variegation and variegation of leaf margins. Thirteen genotypes were used as parents in reciprocal crosses of all possible combinations. Fourteen