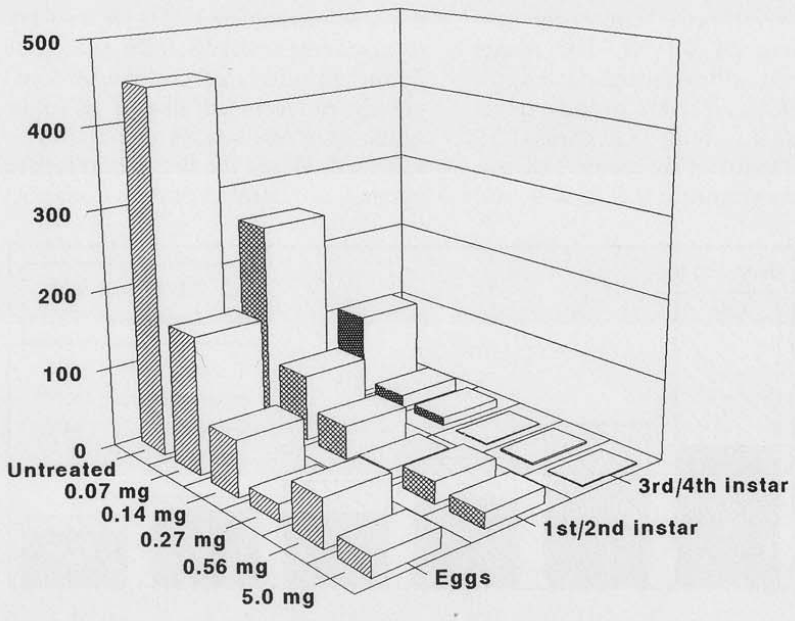

Fig. 4. Mean number of immature silverleaf whitefly eggs, 1st = first and second instar nymphs and 3rd = third and fourth instar nymphs sampled from lower middle and upper poinsettia leaves 57 days after treatment. Bars represent the mean totals of the means of two 2.5-cm leaf discs at each leaf location on five plants per replicate.

called food-chain toxicity is a concern with any systemic pesticide, however, and this must be evaluated.

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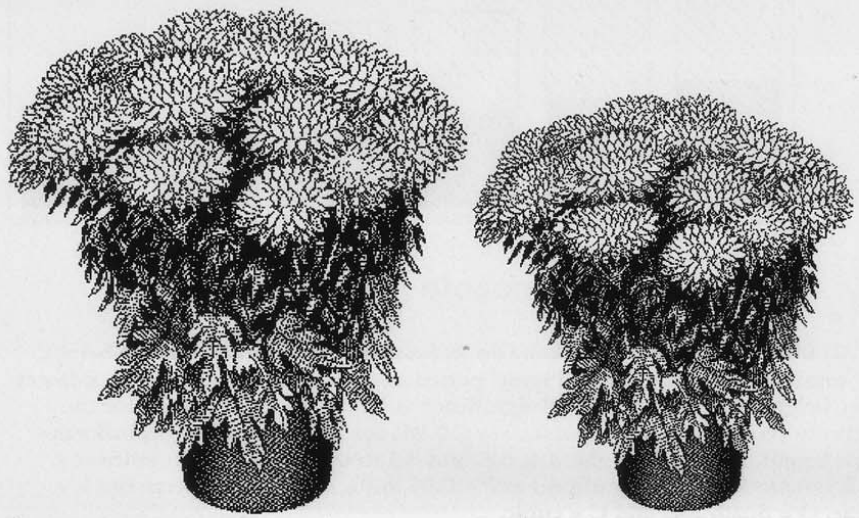

Efficacy of Ancymidol, Paclobutrazol, and Uniconazole on Growth of Tuberous-rooted Dahlias

Brian E. Whipker[1] and P. Allen Hammer[2]

Additional index words. *Dahlia variabilis*, growth retardant

Summary. Plant growth retardant (PGR) substrate drench treatments (mg a.i./1.5-L pot) of ancymidol at doses of 0.5 to 8, paclobutrazol from 1 to 16, and uniconazole from 0.125 to 2 were applied to tuberous-rooted dahlias (*Dahlia variabilis* Willd.) to compare their effectiveness for controlling height. When the first inflorescence opened, the number of days from potting until flowering, leaf canopy height, inflorescence height above the foliage, and plant diameter were recorded. Total height control achieved using PGRs was primarily due to reduced inflorescence height, rather than leaf canopy height. Paclobutrazol, ancymidol, and uniconazole at all doses reduced total plant height of the less-vigorous 'Red Pigmy' by >21% compared to the untreated control, with a height of 43.5 cm for the untreated control plants. Marketable potted plants were produced with doses of 2 to 4 mg of paclobutrazol, 0.25 to 0.5 mg of uniconazole, or 0.5 mg of ancymidol.

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All paclobutrazol, ancymidol, and uniconazole doses reduced total plant height of the more-vigorous 'Golden Emblem' by >11% compared to the untreated control, with a height of 82.1 cm for the untreated control. Marketable potted plants were produced with 4 to 8 mg of paclobutrazol, 0.5 to 1 mg of uniconazole, or 2 mg of ancymidol.

Plant growth retardants (PGRs) are commonly applied to containerized crops when plants are likely to be disproportionately large relative to the container (Barrett et al., 1994; Tayama et al., 1992). Tuberous-rooted dahlias can be excessively large relative to the container, and PGRs are required to control height. De Hertogh and Blakely (1976) recommended applying soil drenches of ancymidol (α-cyclopropyl-α-(4-methoxyphenyl)-5-pyrimidinemethanol) at 0.25 to 2 mg active ingredient (a.i.) per pot, 10 to 14 days after potting the tubers for height control. Foliar sprays (10 to 80 mg·L^{-1}) or drenches (doses up to 2 mg) of paclobutrazol ((+)–(R*,R*)-ß([4-chlorophenyl]methyl)-α-(1,1-dimethylethyl)-1*H*-1,2,4-triazole-1-ethanol) were not effective for controlling plant height of seeded dahlias (Shanks, 1980). Whipker et al. (1995) found no significant reduction in plant height of 'Golden Emblem' tuberous-rooted dahlia plants with paclobutrazol drench doses of up to 1.9 mg a.i./1.5-L pot or uniconazole ((E)-1-(p-chlorphenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl-1-penten-3-ol)) doses up to 0.47 mg a.i./pot. This study was conducted to determine the effectiveness of greater doses of ancymidol, paclobutrazol, and uniconazole as a chemical height control for tuberous-rooted dahlias.

Materials and methods

Dormant tubers of 'Golden Emblem' and 'Red Pigmy' dahlias were potted into 1.5-L round plastic pots on 12 Mar. 1995. The substrate contained 1 soil : 2 sphagnum peat : 2 perlite (by volume) and was amended with (per cubic meter of mix) 890 g $Ca(H_2PO_4)_2$, 593 g KNO_3, 593 g $MgSO_4 7H_2O$, 4.75 kg ground limestone, and 74 g Peter's fritted trace elements no. 555 (Scotts, Marysville, Ohio). Plants were fertilized at each irrigation (mg·L^{-1}) with 201N–46P–200K. Greenhouse day/night setpoints were 24/18 °C. The plants were grown under natural daylength. Fifteen PGR substrate drench treatments (mg a.i./pot) were applied 13 days after potting by using 118 mL per pot: ancymidol at 0.5, 1, 2, 4, and 8; paclobutrazol at 1, 2, 4, 8, and 16; uniconazole at 0.125, 0.25, 0.5, 1, or 2; and an untreated control. A completely randomized design of eight single-plant replications of each cultivar was used. When the first inflorescence opened, the number of days from pot-

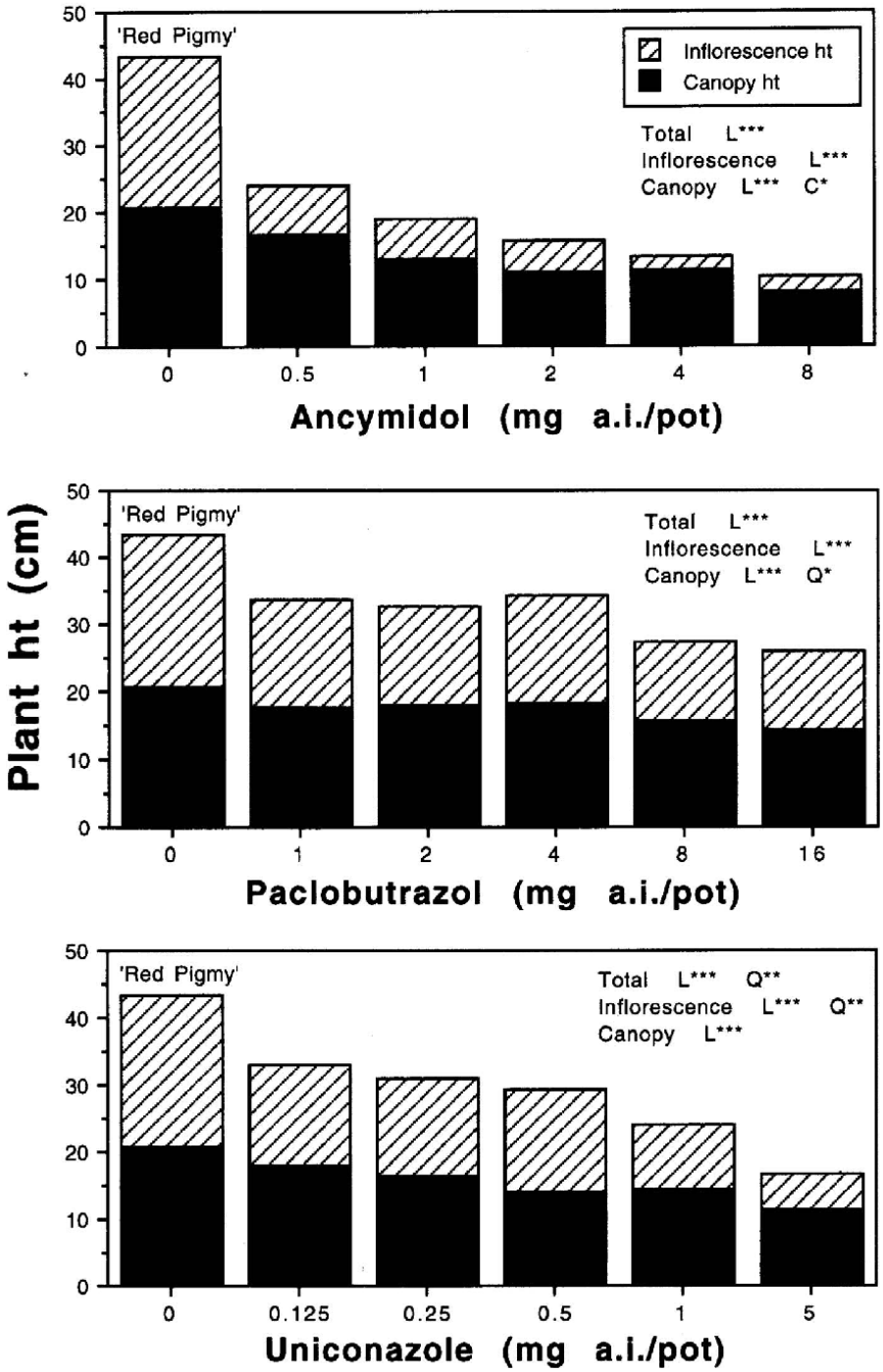

Fig. 1. Effect of PGRs (mg a.i./pot) on leaf canopy height, inflorescence height, and total plant height of 'Red Pigmy' potted dahlias. Leaf canopy height, inflorescence height, and total height all significant at $P \leq 0.001$, respectively, for the cultivar × treatment interaction. LSD ($\alpha \leq 0.05$) for leaf canopy height, inflorescence height, and total height, 3.4, 6.6, and 8.1, respectively, for the cultivar × PGR interaction. *,,***Significant at $P \leq 0.05$, 0.01, or 0.001, respectively; L = linear, Q = quadratic, and C = cubic.**

ting until anthesis, leaf canopy height measured from the pot rim to the top of the foliage, inflorescence height above the foliage, total plant height, plant diameter (measured at the widest dimension and turned 90°, and averaged), and inflorescence diameter (measured at the widest dimension and turned 90°, and averaged) were recorded. Data were tested by analysis of variance by using general linear model procedures (SAS Institute, Cary, N.C.). Means were separated by least significant differences (LSD) at $P \leq 0.05$.

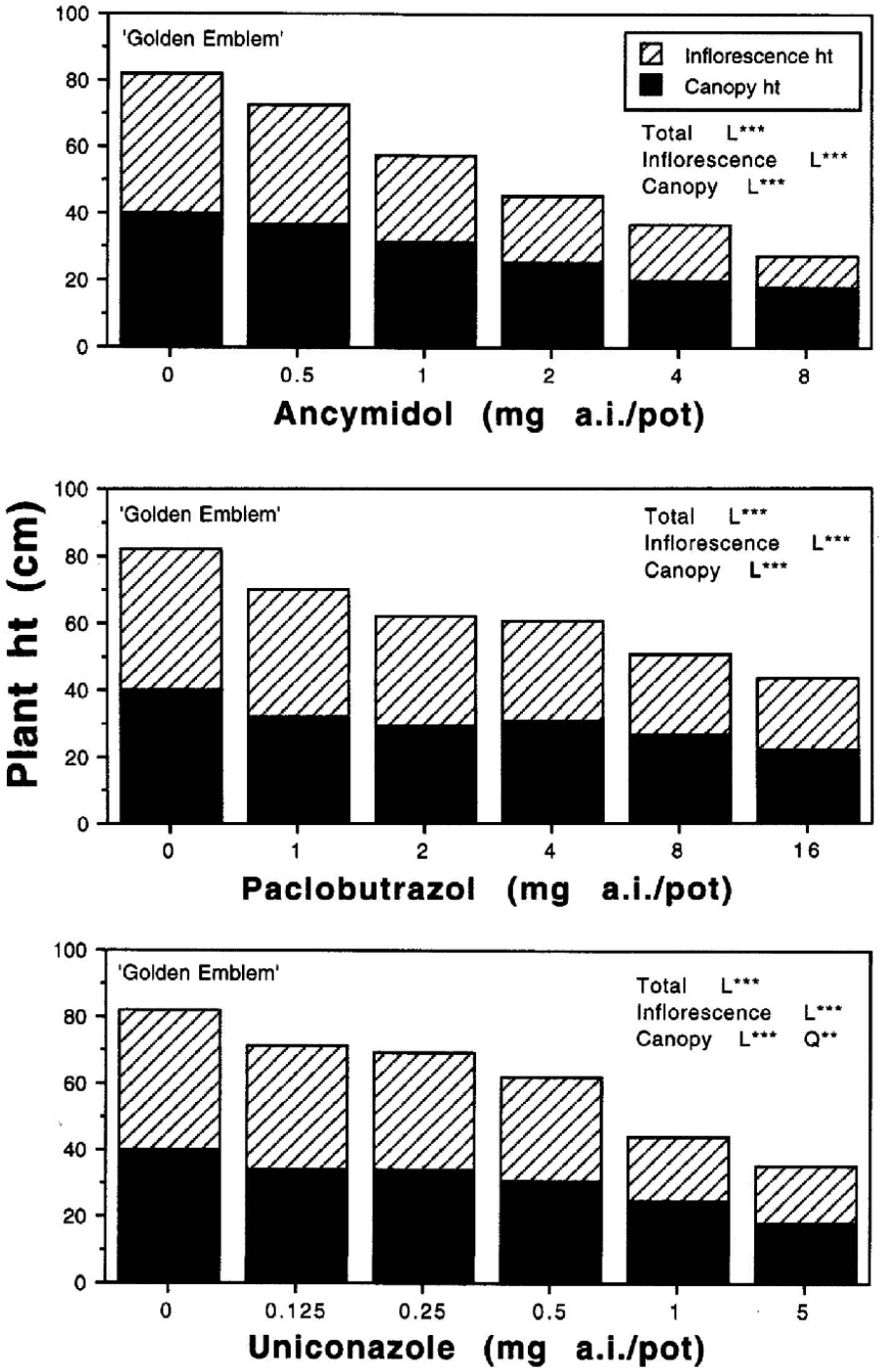

Fig. 2. Effect of PGRs (mg a.i./pot) on leaf canopy height, inflorescence height, and total plant height of 'Golden Emblem' potted dahlias. Leaf canopy height, inflorescence height, and total height all significant at $P \leq 0.001$, respectively, for the cultivar × treatment interaction. LSD ($\alpha \leq 0.05$) for leaf canopy height, inflorescence height, and total height, 3.4, 6.6, and 8.1, respectively, for the cultivar × PGR interaction. *,,***Significant at $P \leq 0.05$, 0.01, or 0.001, respectively; L = linear, Q = quadratic, and C = cubic.**

Results and discussion

Total plant height, leaf canopy height, inflorescence height, plant diameter, and inflorescence diameter showed a significant cultivar × PGR treatment interaction. The PGR main effect influenced days from potting until flowering.

TOTAL HEIGHT. Paclobutrazol, ancymidol, and uniconazole at all doses decreased 'Red Pigmy' total plant height by >21% compared to the untreated control (Fig. 1). Height retardation of 'Red Pigmy' plants was severe and unacceptable with uniconazole drench doses ≥1 mg and for ancymidol drenches ≥1 mg. All paclobutrazol, ancymidol, and uniconazole doses significantly reduced 'Golden Emblem' total plant height by >11% compared to the untreated control (Fig. 2). Severe height retardation of 'Golden Emblem' plants resulted from paclobutrazol drench doses of 16 mg, uniconazole doses of 2 mg, and ancymidol doses ≥4 mg.

CANOPY HEIGHT. 'Red Pigmy' leaf canopy height was significantly shorter compared to the untreated control with paclobutrazol doses ≥8 mg, uniconazole doses ≥0.25 mg, and with all ancymidol doses (Fig. 1). 'Golden Emblem' leaf canopy height was more compact than the untreated control with all PGRs applied, except for the 0.5-mg dose of ancymidol. Reductions of leaf canopy height for 'Golden Emblem' were excessive with paclobutrazol at 16 mg, uniconazole at 2 mg, and ancymidol doses ≥4 mg. Leaf distortion occurred on 'Red Pigmy' with uniconazole doses ≥1 mg and ancymidol doses ≥1 mg, with the severity increasing as the dose increased. Leaf distortion on 'Golden Emblem' occurred only with uniconazole doses of 2 mg and ancymidol doses of 8 mg.

INFLORESCENCE HEIGHT. All paclobutrazol, ancymidol, and uniconazole doses significantly reduced 'Red Pigmy' inflorescence height by >29% compared to the untreated control (Fig. 1). Excessive reductions of 'Red Pigmy' inflorescence height resulted from paclobutrazol drench doses ≥8 mg, uniconazole drench doses ≥1 mg, and ancymidol drenches ≥0.5 mg. Paclobutrazol doses ≥2.0 mg, uniconazole doses ≥0.25 mg, and ancymidol doses ≥1 mg significantly reduced 'Golden Emblem' inflorescence height by >16% compared to the untreated

Table 1. Effectiveness of plant growth regulators (PGRs) on plant and inflorescence diameter for 'Red Pigmy' and 'Golden Emblem' dahlias grown as potted plants.

PGR treatment	Dose (mg a.i./pot)	Plant diam (cm)[z]		Inflorescence diam (cm)[z]	
		Red Pigmy	Golden Emblem	Red Pigmy	Golden Emblem
Untreated control	---	49.3	51.3	10.6	9.3
Paclobutrazol	1	44.1	51.2	10.5	9.3
	2	41.7	48.0	10.3	9.6
	4	42.7	48.4	10.3	9.4
	8	40.5	47.9	10.2	9.9
	16	37.7	40.3	10.2	9.3
Significance		L***	L***	NS	NS
Uniconazole	0.125	43.5	46.4	10.6	9.4
	0.25	43.7	49.0	9.9	9.3
	0.5	41.2	48.5	10.1	9.3
	1	39.5	45.2	10.3	9.3
	2	36.2	42.0	9.7	9.7
Significance		L***	L*Q*	L**	NS
Ancymidol	0.5	41.1	46.7	10.2	9.7
	1	34.5	45.6	9.8	9.4
	2	30.3	41.4	8.9	9.7
	4	27.8	38.2	8.7	9.8
	8	24.1	37.0	7.8	7.9
Significance		L***	L***	L***	L***

[z]Significance (at $P \leq 0.05$ or 0.001) for plant and inflorescence diameter for the cultivar × treatment interaction. LSD ($\alpha \leq 0.05$) was 4.4 and 0.7 cm, respectively, for plant and inflorescence diameter for the cultivar × treatment interaction. Values are means of eight replicates of each cultivar.

NS,*,**,***Nonsignificant or significant by single-degree-of-freedom test for each cultivar by treatment grouping at $P \leq 0.05$, 0.01, or 0.001, respectively, respectively; L = linear, Q = quadratic.

control. Excessive reductions of 'Golden Emblem' inflorescence height resulted from the 8-mg ancymidol drench dose. Most of total height control achieved by using PGRs was primarily due to a reduction of inflorescence height, rather than leaf canopy height.

PLANT DIAMETER. Plant diameter was significantly affected by the PGRs. All PGR applications reduced 'Red Pigmy' plant diameter by >10%, with the effectiveness increasing as the PGR dose increased (Table 1). Paclobutrazol doses ≤8.0 mg did not affect 'Golden Emblem' plant diameter compared to the control, while all uniconazole and ancymidol doses effectively suppressed plant diameter.

INFLORESCENCE DIAMETER. Inflorescence diameter was significantly affected by the PGRs (Table 1). 'Red Pigmy' inflorescence diameter was reduced by >8% with an uniconazole dose of 2 mg or with ancymidol doses ≥1 mg compared to the untreated control. Only the 8-mg dose of ancymidol significantly reduced 'Golden Emblem' inflorescence diameter. No reduction in inflorescence diameter for either cultivar occurred with the paclobutrazol doses used.

DAYS TO FLOWERING. The effects of PGR treatments on the number of days from potting to flowering were similar for both cultivars. No delay in flowering occurred with the doses of paclobutrazol used (Table 2). Only the 2-mg dose of uniconazole delayed flowering compared to the control. All ancymidol doses significantly delayed flowering by 5 days compared to the control.

Conclusions

Sachs et al. (1976) recommended that the optimal plant height should be 1.5 to 2 times the container height. 'Red Pigmy' was a less-vigorous cultivar—the untreated control plants were 43.5 cm high. Marketable potted plants

Table 2. Effectiveness of plant growth regulators (PGRs) on days from potting until flowering and per pot costs of the PGR treatments for 'Red Pigmy' and 'Golden Emblem' dahlias grown as potted plants. Average for both cultivars.

PGR treatment	Dose (mg a.i./pot)	Days to flowering	PGR per pot cost ($)[z]
Untreated control	---	68.7	---
Paclobutrazol	1	72.3	0.021
	2	68.9	0.042
	4	71.4	0.084
	8	71.6	0.169
	16	69.3	0.338
Uniconazole	0.125	69.4	0.021
	0.25	71.8	0.041
	0.5	72.7	0.082
	1	72.9	0.165
	2	75.4	0.330
Ancymidol	0.5	74.2	0.112
	1	73.9	0.224
	2	75.8	0.448
	4	77.3	0.897
	8	80.4	1.793
Significance		***	
LSD ($\alpha \leq 0.05$)		5.2	

[z]Cost (rounded) as of 1 Jan. 1996 based on the use of drench applications of PGRs, corresponding to the cost of $102/quart for paclobutrazol, $78/quart for uniconazole, and $56/quart for ancymidol.

***Significant at $P \leq 0.001$ for the treatment interaction. Average for both cultivars and n = 16.

24 to 34 cm high were produced with doses of 2 to 4 mg of paclobutrazol, 0.25 to 0.5 mg of uniconazole, or 0.5 mg of ancymidol. 'Golden Emblem' was the most-vigorous cultivar, with a height of 82.1 cm for the untreated control. Plants of acceptable height were produced with doses of 4 to 8 mg paclobutrazol, 0.5 to 1 mg of uniconazole, or 2 mg of ancymidol. Even though the plants were 3 to 4 times taller than the pot height of 15 cm, the recommended doses resulted in a minimal amount of leaf distortion, reduction in inflorescence diameter, and delay in the number of days until flowering.

All ancymidol doses significantly delayed flowering of the cultivars grown, while the optimal range of doses found in this study—2 to 8 mg of paclobutrazol and 0.25 to 1 mg of uniconazole—did not delay flowering. Only ancymidol and paclobutrazol are labeled for use on tuberous-rooted dahlias. The decision to use PGRs to control the growth of tuberous-rooted dahlias should be based on the response of the cultivar and the cost of the PGR (Table 2). The desired control of growth was obtained for the lowest cost by using paclobutrazol at the cost of $0.084 to $0.169 per pot for 'Golden Emblem' and $0.042 to $0.084 for 'Red Pigmy', which was 25% to 81% less expensive than ancymidol.

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Instrumented Sphere Used to Identify High-impact Areas on Grapefruit Packing Lines in Texas

Krista C. Shellie[1]

Additional index words. quality, decay, cushioning, bruising, citrus, packing shed, accelerometer, *Citrus paradisi*

Summary. **An instrumented sphere (IS) was used to identify high-impact areas on seven grapefruit (*Citrus paradisi* Macf.) packing lines in the Rio Grande Valley of Texas. The packing-line unit operations having the greatest percentage of high impacts were 1) the sizer, 2) when #2 fruit were separated by hand at the grading table, 3) when fruit were dumped from the harvest bin onto the packing line, and 4) when fruit dropped into a collection bin at the end of the packing line. The number of high impacts and the amount of cushioning in high-impact areas varied among the seven packing sheds. The amount of red dye visible on the surface of fruit collected from the end of each shed's packing line did not correspond with each shed's percentage of high impacts or with incidence of decay during fruit storage. The severity of impacts and degree of cushioning provided in these Texas packing sheds were comparable to that reported for 39 Florida packing houses. This study illustrates the usefulness of the IS for enhancing individual packing-line operations and for comparing individual shed performance to packing-line operations in other agricultural production regions.**

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Quality control during harvest, handling, and marketing is essential for minimizing product loss in the fresh-produce industry. Damage to fresh produce during handling can provide an entry for postharvest pathogens and lower fruit market quality. Bruised tissue may not be immediately visible on the surface of the fruit and therefore difficult to identify and eliminate during grading. The number and magnitude of impacts a fruit receives during harvest and packing-shed operations may influence its postharvest shelf life.

The instrumented sphere (IS) is an 89-mm-diameter sphere containing a triaxial accelerometer, microprocessor, 32K of RAM memory, and a battery encased in beeswax (Zapp et al., 1990). This impact detection device was originally developed by Tennes et al. (1988) to quantify the magnitude of impacts produce was exposed to during harvesting and handling operations and to delineate produce impact tolerance thresholds. The IS has been used to delineate damage thresholds and quantify impacts on onion (Bajema and Hyde, 1995; Peterson, et al., 1991; Timm, et al., 1990), avocado, papaya, pineapple (Timm and Brown, 1991), tomato, bell pepper (Sargent et al., 1992), peach (Lin and Brusewitz, 1994; Schulte et al., 1994), potato (Hyde et al., 1992; Morrow and Ruscitti, 1990; Orr et al., 1994), and apple (Marshall and Burgess, 1991; Sarig et al., 1992; Schulte et al., 1992; Sober et al., 1990; Tennes, et al., 1990) packing lines. The IS has also been used to quantify impacts on citrus packing lines in Florida (Miller and Wagner, 1991a, 1991b), but attempts at delineating damage thresholds for citrus have not yet been realized (Miller and Burns, 1991; Miller and Wagner, 1991a).

In the Rio Grande Valley, grapefruit (*Citrus paradisi*) are usually harvested by hand into wooden field bins and transported to a packing shed for washing, sizing, waxing, grading, and packing. Fruit are often collected into wooden field bins after cleaning, waxing, and grading on the packing line and stored for short periods before they are once again run through a line for packing into shipping cartons. Grapefruit-to-grapefruit impacts and impacts on a hard or somewhat cushioned surface are frequent during these