In comparison to UC86177-treated plants, those in the Envy treatment had higher transpiration rates, while plants in the Vapor Gard treatment were less wilted: other differences were not significant. XPP of impatiens is not reported because of difficulties encountered in measuring XPP of the stems. Impatiens stems are succulent and when pressure was applied, a clear sap oozed from the cut surface of the stem, covered the xylem, and made it impossible to detect water coming from the xylem vessels.

In summary, of the 15 possible outcomes for each antitranspirant compound the results were: UC86177-treated plants were significantly less stressed than the controls 11 times and not significantly different from controls four times; Wilt-Pruf lowered stress levels 10 times and was not different five times; Folicote was beneficial nine times, no different six times; Vapor Gard produced eight beneficial and seven similar results; and Envy-treated plants were less stressed than the controls three times, no different 10 times, and more stressed twice.

Treatment with UC86177, the metabolic antitranspirant, or the four film-forming antitranspirants produced no significant beneficial effect on the water status of doublefile viburnum in either the 1986 or 1988 experiments. Species differences in response to film-forming antitranspirants have been reported by Davies and Kozlowski (1974) and attributed to differences in stomatal anatomy (Andersen et al., 1979). Results with doublefile viburnum seem to indicate that there may be species differences in the efficacy of UC86177.

In these experiments, UC86177 antitranspirant was shown to be as effective or more so than the film-forming products tested for short-term amelioration of water stress in container-grown plants. As a metabolic antitranspirant with a 10- to 21-day efficacy period (Rhone-Poulenc Information Sheet, Feb. 1988), UC86177 may have potential for producing the short-term benefit of protection against- water stress without the long-term deleterious effects associated with the film-forming antitranspirants (Davies and Kozlowski, 1974; Martin and Link, 1978; Andersen et al., 1979). Additional studies with UC86177 are needed to determine activity, optimal rate of application, efficacy period, and potential for reapplication on various plant species.

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Skin Color in 'Newtown' Apples Treated with Calcium Nitrate, Urea, 'Diphenylamine, and a Film Coating

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Abstract. ***'Newtown'*** **apples *(Malus domestics* Borkh.) treated weekly with urea at 10 $g\cdot liter^{-1}$ or $Ca(NO_3)_2$ at 7.5 $g\cdot liter^{-1}$ for 5 consecutive weeks from late August were greener at harvest and during storage than comparable control fruit. A postharvest dip in Nutri-Save, a polymeric coating, was better for retention of skin greenness than a dip in diphenylamine and both gave greener apples than control (nondipped) fruit. Fruit treated with $Ca(NO_3)_2$ displayed lesions that were larger and more numerous than typical bitter pit in the control fruit.**

Although 'Newtown' apples are green during growth, they have a tendency to turn yellow late in the growing season. Yellow skin renders them less attractive to consumers accustomed to 'Granny Smith', the competing cultivar that cannot be grown in British Columbia because the growing season is too short. Treatments that influence skin greenness are high N levels (Williams and Billingsley, 1974; Vang-Peterson et al., 1977; Saitoh et al., 1983), $Ca(NO_3)_2$ sprays (Jones, 1980), and dips in diphenylamine solutions (Little and Taylor, 1981). A 2-year study was conducted at the Summerland Research Station to assess the influence of preharvest sprays of urea and $Ca(NO_3)_2$ and postharvest dips in diphenylamine (DPA) and Nutri-Save (a proprietary fruit coating; Nova Chem, Halifax, N. S., Canada) on retention of skin greenness in 'Newtown' apples. Results on skin color, firmness, acidity, soluble solids concentration, and ripening are reported in this paper.

A block of 'Newtown' apples planted in 1981 at the station was used in this study and trees received the same treatment in both years. Three rootstock and three training systems were present in the 'Newtown' block. However, only two of the training systems were used in the study and treatments were applied to the same plots within the six completely randomized blocks. Plots consisted of two or three trees, depending on the rootstock **x** tree training combination. Urea at 10 $g\cdot liter^{-1}$ and $Ca(NO_3)_2$ at 7.5 $g\cdot liter^{-1}$ (w/v) were applied at weekly intervals for 5 weeks, commencing at the end of Aug. 1986 and 1987. Control trees within each block were left unsprayed. A box of fruit ($\approx$80 fruits) was harvested at commercial maturity

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Table 1. Skin color and incidence of disorders in 'Newtown' apples treated with $Ca(NO_3)_2$ or urea.[z]

Treatment	Storage period (days)	Skin color[x] (0–10)	Fruit with disorders (%) after 7 days at 20C	
			Internal	External
Control	0	1.61 a[x]	---	---
$Ca(NO_3)_2$	0	1.26 b	---	---
Urea	0	1.21 b	---	---
Control	90	2.60 a	6.0 a	1.2 b
$Ca(NO_3)_2$	90	2.00 b	5.8 a	12 a
Urea	90	1.64 c	9.4 a	2.3 b
Control	180	3.05 a	15 a	5.1 b
$Ca(NO_3)_2$	180	2.61 b	14 a	9.3 a
Urea	180	2.06 c	18 a	3.1 b

[z]Mean separation within each storage period by Duncan's multiple range test, $P = 0.05$.
[y]Trees were sprayed weekly with urea at 10 g·liter^{-1} or $Ca(NO_3)_2$ at 7.5 g·liter^{-1} for 5 consecutive weeks from the last week in August.
[x]0 = very green, 10 = very yellow.

Table 2. Skin color in 'Newtown' apples treated with preharvest sprays of $Ca(NO_3)_2$ or urea and postharvest dips in diphenylamine (DPA) or Nutri-Save and stored in 0C air for 90 or 180 days.[z]

Preharvest treatment	Storage (days)	Skin color (0–10)[y]		
		Control	DPA	Nutri-Save
Control	90	2.68	2.62	2.28
$Ca(NO_3)_2$	90	2.25	2.01	1.86
Urea	90	1.70	1.53	1.56
Mean[x]		2.21 a	2.05 b	1.90 c
Control	180	3.37	3.17	2.79
$Ca(NO_3)_2$	180	2.69	2.50	2.25
Urea	180	2.03	2.01	1.58
Mean[x]		2.70 a	2.56 b	2.21 c

[z]Preharvest sprays were urea at 10 g·liter^{-1} and $Ca(NO_3)_2$ at 7.5 g·liter^{-1} applied weekly for 5 consecutive weeks from the last week in August. Postharvest dips were DPA at 3 g·liter^{-1} and Nutri-Save at 10 g·liter^{-1}.
[y]0 = very green, 10 = very yellow.
[x]Mean separation within columns for each storage period by Duncan's multiple range test, $P = 0.05$.

from each of the six replicates within each treatment and stored in 0C air. A subsample of 15 apples was withdrawn at harvest from each box and evaluated for weight, skin color, firmness, percent soluble solids concentration (SSC), and titratable acidity (TA). Additional 40-fruit samples were withdrawn after 90 and 180 days of storage; of these, 15 fruit were immediately assessed for skin color, firmness, SSC, and TA. The remaining 25 fruits were ripened at 20C for 7 days and assessed for incidence of external and internal disorders.

Sufficient fruit was also picked at harvest from the control, urea-sprayed, and $Ca(NO_3)_2$-sprayed trees in all blocks to provide 15 randomized subsamples of 2.5 apples within each treatment. Five subsamples within each treatment were dipped in solutions of DPA at 3 g·liter^{-1} or Nutri-Save at 10 g·liter^{-1} or they were left undipped (controls). All samples were stored in air at 0C and examined for skin color after 90 and 180 days of storage.

Color was determined with a Golden Delicious Apple Meter (Techwest Industries, Vancouver, B. C., Canada) and firmness measured with a Magness-Taylor penetrometer (11. l-cm tip). Sectors from the 15-apple samples were juiced in a commercial unit. TA was deter-mined by titration and SSC with a hand-held refractometer. Two additional sectors (free of skin, seeds, and carpel tissue) from each fruit within the 15-apple sample were freeze-dried and ground in a Wiley mill. Flesh calcium of the powder was determined by atomic absorption spectrophotometry.

Data were analyzed by analysis of variance as a completely randomized block design for the preharvest and postharvest treatments. All proportional data were transformed into their respective arcsin $x^{1/2}$ values.

Skin color in urea- and $Ca(NO_3)_2$-treated fruit was similar at harvest but greener than that in control fruit (Table 1). However, the skin was significantly greener during storage in urea-treated fruit than in $Ca(NO_3)_2$-treated fruit and both were greener than control fruit. External disorders (bitter pit-type lesions) were considerably more common in the $Ca(NO_3)_2$-treated fruit than in other fruit, but incidence of internal disorders (core flush) did not differ with treatment. Fruit weight, firmness, SSC, and TA were not influenced by the treatments either at harvest or during storage (data not shown). A postharvest dip in Nutri-Save helped retain skin greenness better than a dip in DPA and both gave greener fruit than nondipped fruit (Table 2).

The beneficial effect of N on skin greenness was also observed in studies by Williams and Billingsley (1974), Vang-Petersen et al. (1977), and Ruiz et al. (1986). However, size was also enhanced in their studies, an undesirable trait because it can reduce storage potential. Calcium nitrate sprays reduced redness in 'Starkrimson' apples in Tasmania, but had no detrimental effects on the fruit (Jones, 1980). It is unlikely that the lesions observed in the $Ca(NO_3)_2$-treated apples in the present study were bitter pit because flesh Ca content was higher than in control fruit (data not shown). Lesions were 5 to 10 mm in diameter, reddish, somewhat depressed, and contained brown tissue to a depth of 5 mm. Bitter pit lesions in control fruit were smaller, usually 2 to 5 mm in diameter and depth.

Pears coated with Nutri-Save were greener than control fruit but failed to ripen properly (Meheriuk and Lau, 1988). Coated 'Newtown' apples remained greener than noncoated fruit and ripened normally. The beneficial effect of DPA on skin greenness in 'Granny Smith' (Little and Taylor, 1981) was not observed with our 'Newtown' apples.

In summary, foliar application of urea and calcium nitrate can enhance skin greenness in 'Newtown' apples, but skin injury in the form of bitter pit-type lesions was observed with the preharvest $Ca(NO_3)_2$ sprays. Postharvest application of Nutri-Save also enhanced retention of skin greenness. DPA dips were not effective.

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