Table 5. Effects of washing on postharvest dips in preventing damage disorders in 'Van' cherries, 1978 crop.

Dipping solution	Concn (g/liter)	Wash time	Bruised fruit (%)	Pitted fruit (%)
Water		None	5 b	63 a
		Before bruising	5 b	62 a
		After bruising	3 b	63 a
Keltrol	2.5	None	4 b	43 b
		Before bruising	3 b	58 a
		After bruising	10 a	54 a
$CaCl_2$	30	None	3 b	41 b
		Before bruising	2 b	61 a
		After bruising	6 b	60 a
$CaCl_2$ + Keltrol	30 2.5	None	3 b	30 c
		Before bruising	6 b	46 b
		After bruising	5 b	42 b

[z]Mean separation within columns by Newman Keuls' test, 5% level.

formation of sunken pits. $CaCl_2$ applied without thickener and not washed off prior to storage and $CaCl_2$ applied with thickener significantly decreased the incidence of surface pitting. However, dipping fruit in $CaCl_2$ with thickener was most effective in reducing surface pitting when the fruit remained unwashed. Washing the dipping solution from the surface of the fruit might be expected to decrease the surface supply of calcium for penetration and hence reduce the efficiency of a $CaCl_2$ dip. However, substantial reductions in the incidence of surface pitting resulted from $CaCl_2$ plus thickener dips even when washed immediately after dipping. This suggests that dipping fruit may have commercial application in reducing surface disorders. The fruit may be dumped into a $CaCl_2$ plus thickener solution prior to the cluster cutter in a commercial packing line. The $CaCl_2$ plus thickener dip may then be washed off the fruit prior to sorting. This procedure could result in 30% reduction in the incidence of surface pitting.

Increased fruit Ca levels resulting from preharvest $CaCl_2$ sprays (7) and postharvest $CaCl_2$ dips (6) were negatively correlated with the incidence of surface pitting. Infused Ca may function by reacting with free carboxyl groups of polygalacturonic acid molecules to increase the intercellular bond strength (1, 3), thus increasing the tissue resistance to impact damage.

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Minimum Critical Foliar Levels of K, Mg, and B in Rieger Elatior Begonia[1]

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Additional index words. nutrition, foliar analysis, tissue analysis, *Begonia* X *hiemalis*

Abstract. **Analysis of deficiency symptoms and foliar analyses of canopy leaves (youngest leaves 5 cm of wider) of Rieger elatior begonias (*Begonia* X *hiemalis* Fotsch cv. Schwabenland Red) indicated that the minimum critical levels for K, Mg, and B lie in the ranges of 0.93 to 0.95%, 0.22 to 0.25%, and 13.0 to 14.0 ppm, respectively.**

Nutritional requirements of the elatior begonia are modest. The effects of nutrient deficiencies and toxicities, however, are pronounced and unlike other crops such as chrysanthemum, are very persistent. Nutritional monitoring therefore is important.

Visual symptoms for deficiencies of N, P, K, Ca, Mg, Fe, and B have been reported (7). Foliar analysis is of greater value since a problem may be identified before irreversible damage occurs. A sampling procedure has been developed for foliar analysis of elatior begonia requiring analysis of canopy leaves; the youngest leaves 5 cm or wider (6). Nelson et al. (6) have established critical concentrations for 3 nutrients in canopy leaves of 'Schwabenland Red' elatior begonia. The

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minimum critical level of N is 4.7% until 3 weeks prior to harvest, after which it drops rapidly. The maximum critical level of N decreases from 6.2% at 5 weeks of age to 4% at harvest time. The minimum critical level for P lies in the range of 0.19 to 0.20% and for Ca in the range of 0.43 to 0.54%.

The objective of this study was to determine the minimum critical levels of K, Mg, and B in the canopy leaves of elatior begonia 'Schwabenland Red.'

Materials and Methods

Newly rooted plants of 'Schwabenland Red' Rieger elatior begonia were soaked in tap water for 5 min prior to planting to remove soluble nutrients applied during propagation to the rooting medium of sphagnum peatmoss and perlite. Plants were grown in a greenhouse in 12.5 cm diameter plastic pots containing acid-washed quartz sand. Night and day temperatures of 18° and 24°C were maintained when season of the year permitted. Nutrients were applied with each watering twice daily. Pots had bottom drainage holes and solutions were not recycled. All essential nutrients were provided in the control treatment and all except K, Mg, or B in 3 other treatments (Table 1). Solutions were formulated in distilled water. Each treatment was applied to 2 replications of 10 pots each.

The experiment was conducted twice with the first being initiated on October 30, 1975 and the second on February 26, 1976. Plants were established under long-day conditions by providing a minimum of 108 lux of incandescent light each night from 2200 to 0200 hr for a period of 4 weeks in the first experiment and 5 weeks in the second. Periodically, visual observations were recorded and canopy leaves were analyzed for either K, Mg or B depending on which was eliminated in the fertilizer treatment. The canopy leaf contents of 10 essential nutrients were determined on the 46th day of each experiment when deficiencies of each test nutrient were established or at least incipient. Canopy leaves were the leaves recommended by Nelson et al. (6) for foliar analysis and were the youngest leaves 5 cm or greater in width.

Sampled leaves were washed for 1 min in 0.2 N HCl, rinsed in distilled water, dried overnight at 70°C, and ground in a 20-mesh stainless steel Wiley mill. Total N was determined by a modified Kjeldahl procedure (1); Ca, Mg, Fe, Mn, Zn, and Cu by atomic absorption spectrophotometry; K by flame spectrophotometry; P by the vanadomolybdophosphoric colorimetric procedure (3); and B by the curcumin procedure (3). Leaf content data were analyzed by a LSD mean separation test where an analysis of variance test showed significant differences at a 5% level of confidence. A confidence interval of ± 1 SD was assigned to the minimum critical levels of K, Mg and B established in this study. The SD were determined from 25 canopy leaf samples collected from a uniform crop of elatior begonia 'Schwabenland Red.'

Results and Discussion

Potassium. The mean K concentration of canopy leaves from the –K treatment of both experiments are presented in Fig. 1. The lowest level associated with normal plants (not showing nutrient stress symptoms) and the highest level associated with plants having deficiency symptoms are 0.95 and 0.93% of the dry weight, respectively. The minimum critical K level lies in this range.

The mean K content of 25 samples drawn from a single commercial crop of elatior begonias was 2.32%, the SD was 0.29% and the coefficient of variability (CV) was 12.4%. Placing a confidence interval of 1 SD around the minimum critical range yields a minimum range of 0.81 to 1.07% K.

Forty-six days after planting, symptoms of K deficiency were well developed and the K content of canopy leaves of plants on the –K treatment (Table 2) was significantly lower than that of canopy leaves in the control treatment. All other nutrients tested appeared to be in a satisfactory range. The K levels of control plants (Table 3) were well above the minimum critical range throughout both experiments.

The first symptom appeared on the oldest leaves as 5-15 mm wide light green patches across the leaf and 3-4 mm wide light green circles along the margin of the leaf. This was the situation at a canopy leaf concentration of 0.93 to 0.95% K. The chlorotic marginal spots of the oldest leaves became necrotic and the leaves between these and the canopy leaves became chlorotic in a similar manner when the canopy leaf concentration dropped to 0.70% K. Symptoms spread upward on the plant until at a concentration of 0.60% K chlorosis began to develop in the canopy leaves. Potassium deficient plants were 40% smaller than control plants. The leaf below the canopy leaf developed marginal necrosis, the canopy leaf was chlorotic, and plants were 55% smaller than control plants at a canopy leaf concentration of 0.54% K. Canopy leaves developed necrosis at a concentration of 0.40% K.

Magnesium. The lowest canopy leaf Mg concentration associated with normal plants and the highest concentration related to Mg deficient plants was 0.25 and 0.22%, respectively (Fig. 2). The minimum critical level lies within this range. The means, SD, and CV for the Mg content are 0.42, 0.07, and 17.9%, respectively. Applying 1 SD, the confidence interval around the minimum critical Mg range is 0.18 to 0.29%.

Table 1. Nutrient formulations used for the 4 treatments in this study to determine the minimum critical levels of K, Mg, and B in elatior begonia canopy leaves.

Salt[z]	Concentration (mM)			
	Treatment solution			
	Complete	–K	–Mg	–B
KNO_3	5	0	5	5
$Ca(NO_3)_2 \cdot 4H_2O$	5	5	5	5
$MgSO_4 \cdot 7H_2O$	2	2	0	2
KH_2PO_4	1	0	1	1
$NaH_2PO_4 \cdot H_2O$	0	1	0	0
$NaNO_3$	0	5	0	0
Na_2SO_4	0	0	2	0

[z] H_3BO_3 was included in each formulation at a concentration of 9.25×10^{-2} mM except in the –B formulation where none was included. All formulations also included the following: 7.16×10^{-2} mM Fe DTPA, 1.82×10^{-2} mM $MnCl_2 \cdot 4H_2O$, 1.53×10^{-3} mM $ZnCl_2$, 1.57×10^{-3} mM $CuCl_2 \cdot 2H_2O$, and 1.03×10^{-4} mM $Na_2MoO_4 \cdot 2H_2O$.

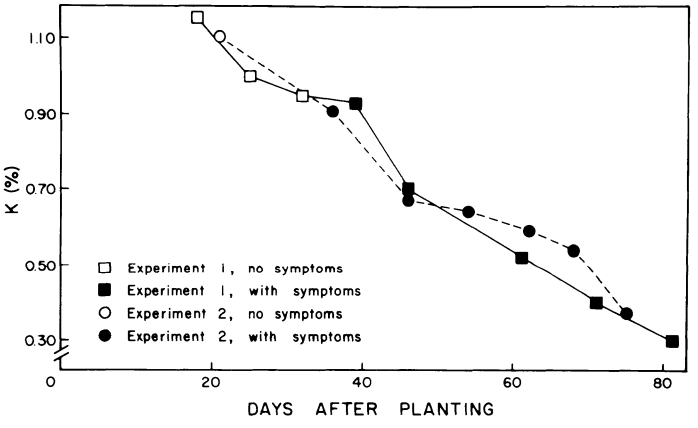

Fig. 1. K concentration in canopy leaves of 'Schwabenland Red' elatior begonia plants grown in 2 experiments on a nutrient formulation containing no K but an adequate level of all other essential nutrients.

Table 2. Nutrient content of elatior begonia canopy leaves from all treatments in both experiments on the 46th day of growth. All treatment nutrients were deficient at the time of analysis except B in the first experiment, which was at incipient deficiency.

Treatment	Expt.	Leaf concentration N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	B (ppm)
Control	1	4.85	0.60	3.15	0.93	0.45	115	91	37	12.6	116
–K	1	4.73	0.62	0.70*	1.06	0.71*	154	101	36	13.1	119
–Mg	1	4.70	0.60	2.80	0.78	0.22*	130	89	39	18.3	123
–B	1	4.35	0.60	2.75	0.84	0.42*	106	79	30	10.4	14*
LSD 5%	1	NS	NS	0.93	NS	0.024	NS	NS	NS	NS	13.3
Control	2	4.84	0.57	3.55	1.06	0.52	86	86	29	8.2	131
–K	2	4.38	0.54	0.67*	1.07	0.75*	89	86	29	10.4	–
–Mg	2	4.66	0.47	3.10	0.98	0.15*	97	100	28	9.0	–
–B	2	3.96	0.45	2.85	0.91	0.42*	69	77	24	7.3	12*
LSD 5%	2	NS	NS	0.80	NS	0.078	NS	NS	NS	NS	15.5

*These means differ significantly from the control treatment mean as determined by a LSD, 5% level.

Table 3. Nutrient content of elatior begonia canopy leaves of control plants from day 18 to 81 in both experiments of this study.

Nutrient	Expt.	Day 18	21	25	32	36	39	46	54	61	62	68	71	75	81
K (%)	1	3.85	–	3.60	3.25	–	3.75	3.15	–	3.35	–	–	3.20	–	3.70
	2	–	3.60	–	–	3.45	–	3.45	3.00	–	2.55	2.60	–	2.10	–
Mg (%)	1	0.60	–	0.58	0.57	–	0.56	0.45	–	0.48	–	–	0.50	–	0.55
	2	–	0.60	–	–	0.49	–	0.52	0.39	–	0.46	0.47	–	0.38	–
B (ppm)	1	100	–	116	105	–	108	116	–	167	–	–	190	–	213
	2	–	105	–	–	99	–	131	–	–	–	112	–	78	–

Analyses of canopy leaves of –Mg plants (Table 2) and control plants (Table 3) indicate that symptoms are due to Mg deficiency alone. The first symptom of Mg deficiency appeared as light green lower leaves at a canopy leaf concentration of 0.22 to 0.25% Mg. This chlorosis soon developed into 5-10 mm patches between the veins and twoard the leaf margin. By the time the canopy leaf concentration of Mg reached 0.15%, chlorotic areas had progressed to necrotic half-moon patches up to 2 cm wide along the leaf margin. The color was brownish-green and there were light tan concentric rings 2 mm apart in the necrotic spots. The necrotic areas enlarged, coalesced and moved inward. When the canopy leaf Mg concentration reached 0.13%, necrosis extended upward to the leaf immediately below the canopy leaf. Patches of cells 1-4 mm in diameter became sunken and grey on older leaves. They then turned light tan and enlarged. These spots occurred at random between the margin and a point 1-2 cm from the center of the leaf. The first necrosis occurred on the canopy leaf at a Mg concentration of 0.11% and on all foliage at a canopy leaf concentration of 0.08%.

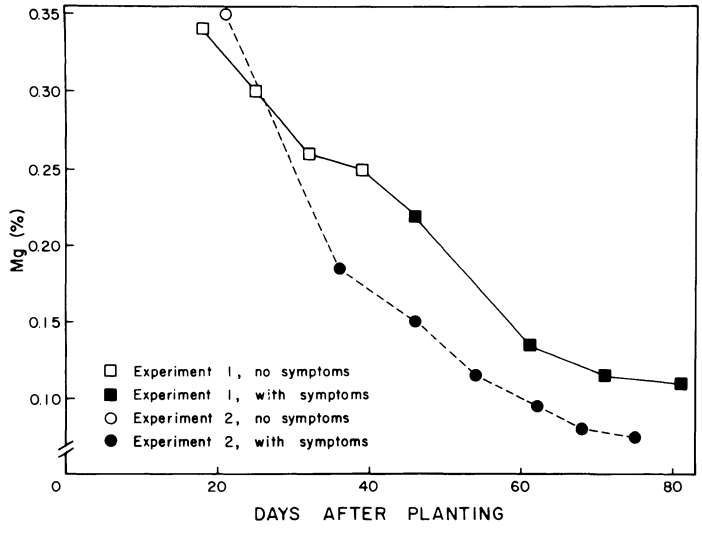

Fig. 2. Mg concentration in canopy leaves of 'Schwabenland Red' elatior begonia plants grown in 2 experiments on a nutrient formulation containing no Mg but an adequate level of all other essential nutrients.

Boron. The minimum critical concentration of B in the canopy leaf lies between 13.0 and 14.0 ppm (Fig. 3). The mean concentration, SD, and CV for 25 sub-samples from a uniform crop are 72.0, 1.4, and 1.9%, respectively. A confidence interval of 1 SD extends the minimum critical range from 12.8 to 14.3 ppm.

Analysis of other nutrients in the canopy leaves indicates that the observed symptoms in the first experiment were due to B deficiency alone. In the second experiment they could be due to B deficiency or possibly the slightly low N concentration. Although the N concentration in the –B treatment plants were not significantly lower than in the control plants, the N value in the –B treatment of the second experiment was slightly below the minimum critical confidence range for N (minimum critical level 4.7%, confidence range of 1 SD 4.2 to 5.2%). The symptoms of N deficiency, however, are distinctly different from those of B deficiency and no confusion was encountered.

B deficiency symptoms appeared at a canopy leaf concentration between 13.0 and 14.0 ppm in the form of shortened

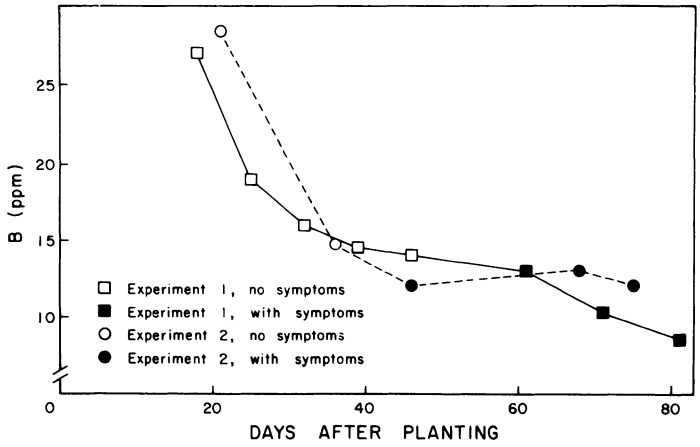

Fig. 3. B concentration in canopy leaves of 'Schwabenland Red' elatior begonia plants grown in 2 experiments on a nutrient formulation containing no B but an adequate level of all other essential nutrients.

internodes. When the B level dropped to 12.0 ppm the petioles of young leaves became soft to the touch. The upper surfaces of young petioles and peduncles turned bronze and the vascular tissue developed a rust color. Cracks developed perpendicular to the long axis of the petioles and peduncles and leaves and flowers began to break off at these points. At a canopy leaf concentration of 9.0 to 10.0 ppm B young leaves became brittle and 1-3 mm sunken, rust colored spots developed near the point of attachment of the petiole and leaf blade. These spots developed later at random across the entire leaf blade. The leaves became crinkled and a random yellow mottling developed. Few flower stalks developed and occasionally only green bracts formed on these. Plants were severely stunted due to shortened internodes.

Interactions. Few interactions occurred in the uptake of nutrients as a result of treatment (Table 2). Mg uptake was significantly enhanced in both experiments by the elimination of K in the nutrient solution. Although not well documented, this is a relationship which is occasionally noted on various crops (2, 5). A second significant interaction was seen in the form of low Mg levels in plants receiving no B. Although significant, the magnitude of Mg suppression was very small. Neither the –K enhancement nor the –B suppression of Mg uptake resulted in injurious tissue levels of Mg.

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The Dormancy Status of Apple Buds as Determined by an *In Vitro* Culture System[1]

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Additional index words. tissue culture, *Malus domestica*

Abstract. **Single axillary bud explants of apple (*Malus domestica* Borkh.) were removed from 'Antonovka' seedlings or from 'Delicious' trees budded on seedling rootstocks, and cultured aseptically under controlled conditions. Many excised buds grew, even though similar buds on intact resting trees did not. Chilling excised buds of 'Antonovka' seedlings for 2 weeks *in vitro* did not increase the number of bursting buds, but promoted shoot elongation on some dates. Chilling 'Delicious' trees for 6 and 8 weeks before excising buds promoted both bud burst and shoot elongation. A substantial number of buds excised from 'Delicious' trees chilled for as long as 21 weeks did not burst, suggesting other limiting factors.**

Lateral shoots of apple and many other woody plants of the temperate zone arise from axillary buds formed the previous year. Generally, axillary buds either develop into vegetative shoots the year following formation, or remain dormant for an indefinite period. Some lateral buds, particularly those on highly vigorous trees, grow into shoots during the year of formation. This may also occur if the buds are released from apical dominance because of damage to or removal of the shoot tip.

Growth of lateral buds appears to be controlled by at least 2 factors. On current season's growth apical dominance usually prevents bud break. Removal of the shoot tip early in the growing season allows one or more of the upper lateral buds to grow. As the growing season progresses, the rest influence progresses steadily from the base to the apex of the shoot, so that

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