decrease occurred regardless of the no. of hills in a plot. In the 1971 estimates, half of a unit of the cotyledon feeding damage rating (about 12% cotyledon defoliation if the rating was above 2) could be detected when the 1 HPP size was replicated 6 times. To detect the same difference, the 2 and 3 HPP designs would require 4 reps (8 hills/cultivar) and 3 reps (9 hills/cultivar), respectively.

A difference of about 20% seedling reduction in hill stand was detected with a 1 HPP design with at least 6 replicates. More hills/cultivar would have been required to detect this difference using 2 or 3 HPP designs.

Single-hill plots may be most practical because maximum differences between resistant and susceptible material are desired during the screening phase (4). Maximum differences are preferred because light infestations may not give adequate variation between cultivars. In very severe infestations, however, the researcher must also be careful not to eliminate potentially valuable cultivars which, under such conditions, may exhibit only moderate resistance.

While cultivar differences are detectable in either 5, 15 or 25 SPH seeding rates, the 15 SPH rate may be most economical. A more reliable seedling reduction value may also be obtained from 15 SPH than with just 5 SPH. Susceptibility measurements at 15 SPH were greater than at 5 SPH and not significantly different from 25 SPH.

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# Texture Modification of 'Van' Sweet Cherries by Postharvest Calcium Treatments[1]


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*Additional index words. Prunus avium,* calcium



*Abstract.* **Calcium (Ca) moved rapidly into sweet cherry fruit (*Prunus avium* L.) flesh and reached a maximum in 7 days after a postharvest calcium chloride ($CaCl_2$) dip. Flesh Ca content was increased by increasing the $CaCl_2$ or thickener concentration or by prolonged immersion time in the dipping solution. After 21 days of 0°C storage, texture attributes of fruit firmness and bioyield were positively correlated with fresh Ca levels.**


Softness in sweet cherries has been ascribed to over-maturity, excessive rainfall or irrigation immediately prior to harvest, excessive fruit set and damage which occurred during picking and handling (13). Induced Ca deficiency was also reported to reduce fruit firmness and to result in lower insoluble pectic substances in 'Montmorency' cherries (4).

Softening of fruit was reported to be caused by solubilization of Ca ions from the galacturonic acid cross-linkages (1) which are responsible for the middle lamella cementing structure (5) binding cell walls together (3). Ca was thought to interact with pectic compounds of cherries to increase fruit firmness (6, 12). Addition of Ca to Montmorency cherries increased firmness of the processed product after canning (2, 7).

The present study investigates the effects of postharvest $CaCl_2$ dips on the uptake of Ca by the fruit flesh of 'Van'


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[3]Keltrol is the brand name for food grade xanthan gum produced by Kelco Division of Merck and Co., Inc.

[4]Super Spread is the brand name for non-ionic surfactant produced by Niagara Chem. Co.

[5]Benlate is the brand name for benomyl, a fungicide produced by Dupont Chem. Co.

sweet cherries. The effects of $CaCl_2$ and thickener concn and fruit immersion time in the dipping solution on fruit firmness and flesh Ca levels, measured after storage, were studied.

## Materials and Methods

*Rate of calcium penetration.* 'Van' cherries of uniform size and red-mahogany maturity were harvested and randomized into 4 replications of approximately 1,000 fruit each. The fruits were cooled immediately by placing in refrigerated storage at 0°C. A single sample of 50 untreated fruit was removed from each replication prepared for Ca analysis by being washed, destemmed, pitted and frozen at −37°C. The remaining fruit were dipped for 15 sec in a solution of 40 g/liter calcium chloride (70% commercial grade, 7.6 g Ca/liter plus 2.5 g/liter Keltrol[3] plus 1.0 ml/liter Super Spread[4] (non-ionic surfactant) plus 0.5 g/liter Benlate[5] at 21°C (Keltrol was included as a thickening agent to adhere dipping solution to the fruit). The fruit was allowed to drain and a second sample of 50 fruit was prepared for Ca analysis. The remaining fruit were placed in corrugated paperboard boxes lined with perforated 1.5 mil (38 um) polyethylene to prevent desiccation. Fifty fruits were removed at successive intervals of 1, 2, 4, 7, 14, 21 and 28 days after dipping, and prepared for Ca analysis according to the above procedure.

*Thickener effect on $CaCl_2$ dip.* 'Van' cherries of uniform size were harvested at red-mahogany maturity and randomized into 12 treatments with 4 replications per treatment. Fruits were placed immediately into refrigerated storage overnight, until fruit temp equilibrated to 0°C. One hundred fruits were dipped for 15 sec in solutions of 0, 20, 40 or 80 g/liter $CaCl_2$ each at a thckener concn of 0, 2.0, 4.0 g/liter Keltrol. All dipping solutions contained 1.0 ml/liter non-ionic surfactant and were maintained at 21°C. Dipped fruit were returned into polyethylene-lined boxes and returned to 0°C storage. The fruit were removed from storage after 21 days and 15 fruit were warmed to 21° for firmness determinations. The remaining 85 fruit were washed, de-stemmed, pitted and frozen at −37° for Ca analysis.

*Dipping duration.* 'Van' cherries of uniform size were harvested at red-mahogany maturity and randomized into 2 series of 5 treatments each with 4 replications of 100 fruit. The 5 treatments in the first series consisted of a control and 4 others that were dipped for 0.25, 10, 60 or 240 min in a solution of 40 g/liter $CaCl_2$ plus 1.0 ml/liter non-ionic surfactant plus 0.5 g/liter Benlate. The second series was treated similarly to the first but with the addition of 2.5 g/liter Keltrol to the dipping solution. Warm fruit (21°C) were dipped after harvest in a 21° solution. All fruit were placed in boxes with perforated polyethylene liners and stored at 0° for 21 days. Upon removal, 15 fruit were allowed to warm to 21° and tested for firmness. The remaining 85 fruit were frozen for Ca analysis.

*Ca analysis.* Frozen fruit samples for Ca analysis, were removed after 5 days at −37°C and peeled to provide flesh tissue only. The remaining fruit flesh was allowed to thaw and then homogenized in a Waring blendor for 5 min to provide a mascerate of the parenchyma tissue. About 5 g of homogenized cherry tissue was weighed into a dry, tared 50 ml beaker. The tissue was freeze dried and the beaker reweighed to obtain tissue dry wt. The cherry tissues were then ashed at 550°C for 3 hr. The ashed samples were then taken up in 25 ml of 0.5N HCl with 6500 ppm La added and the resultant solution analyzed by atomic absorption spectroscopy. The Ca values were expressed on a dry wt basis.

*Firmness determinations.* Cherry firmness was determined by the method of Lidster et al. (8). Fifteen individual cherries were tested using an Ottawa Texture Measuring System (15) with a crosshead speed of 1.5 cm/min. The force-deformation curve was recorded by a strip chart recorder. The bioyield and firmness (slope) values were determined from the strip charts and averaged over the 15 individual values. Deformation values were determined as the length of travel of the crosshead between initial contact with the fruit and the onset of bioyield. Fruit firmness values were determined to be a measure of the cherry resistance to deformation, whereas bioyield was the force at which fruit cells just started to rupture.

## Results and Discussion

Ca penetrated the fruit flesh rapidly (Fig. 1) and approached an asymptotic maximum level 7 days after the $CaCl_2$ dip. The cherry cuticle and epidermis were very permeable to Ca

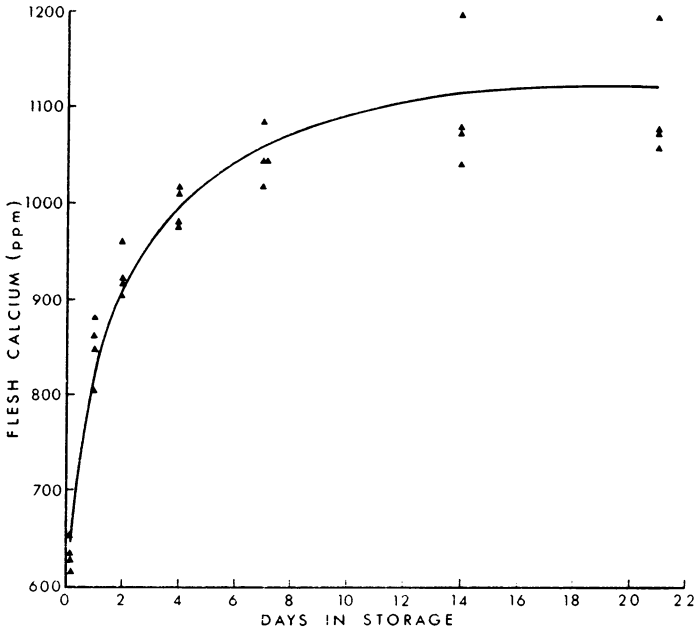


Fig. 1. Ca penetration into 'Van' cherry. Log ppm Ca = 2.920−0.003430 + 0.1536 Log Day ($P < 1\%$, $R^2 = 0.94$). Flesh Ca of undipped control = 630 ppm.

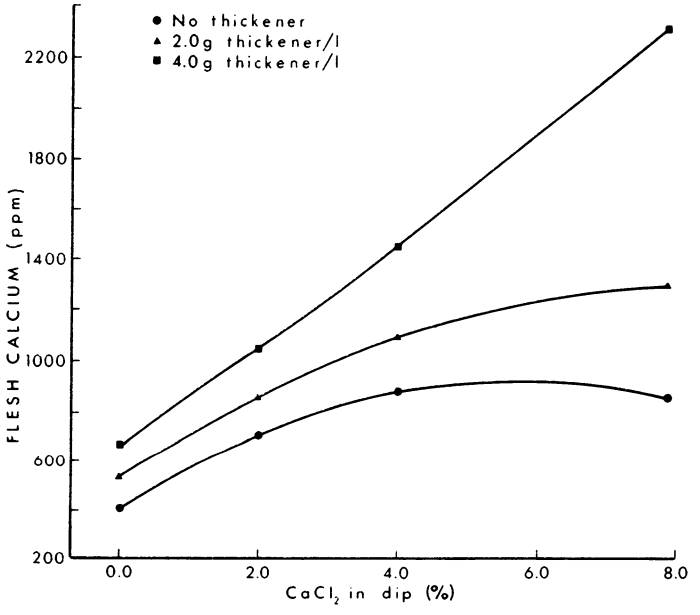


Fig. 2. Effect of $CaCl_2$ and a thickener applied as a postharvest dip on flesh Ca content in 'Van' cherry. ppm Ca = 400.5+185.1 dip Ca+ 66.72 Keltrol+116.9 $Ca^2$·Keltrol$^2$−15.90 $Ca^2$ ($P < 1\%$, $R^2 = 0.94$).

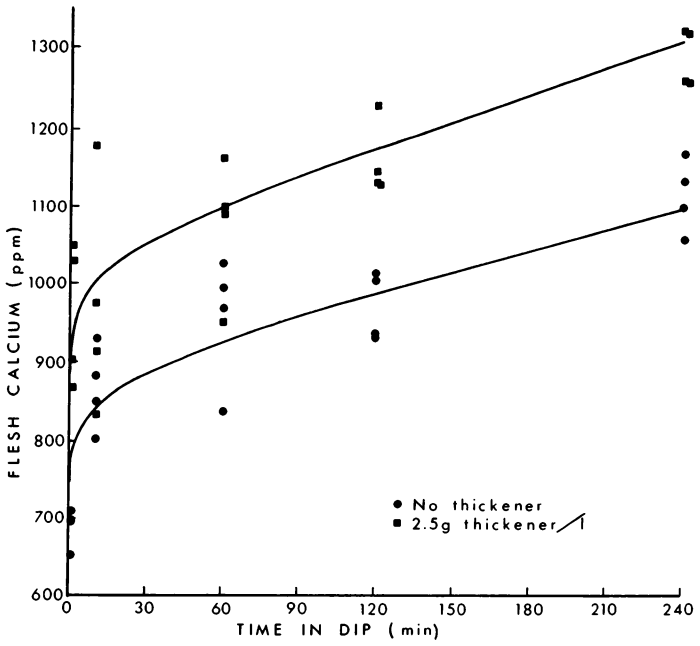


Fig. 3. Effect of dipping time on flesh Ca content in 'Van' cherry. Log ppm Ca = 2.8896+0.0003204 Min + 0.07688 thickener + 0.03250 Log Min. ($R^2$ = 0.77, P = 0.01). Flesh Ca of undipped control; 520 ppm.

movement allowing a 100 ppm increase in flesh Ca concn even when fruit were washed immediately after dipping. This observation was consistent with those which show that water could move rapidly into cherry fruit to cause cracking (14). The rate of Ca uptake by the cherry fruit declined after the first day until after 7 days in storage when small increases in Ca uptake were evident. The high Ca concn in fruit tissues at 7 days or later correspond to the greatest efficiency of $CaCl_2$ dip to reduce surface disorders as previously (data not shown) observed. Apparently, the Ca concn in the fruit flesh equilibrated with the residual Ca within 7 days of dipping.

Flesh Ca concn was increased by raising $Ca Cl_2$ concn in the postharvest dipping solution (Fig. 2). Addition of a thickener to the $CaCl_2$ dip further increased Ca uptake by the fruit. A dipping solution containing 8% $CaCl_2$ and 0.4% Keltrol resulted in a 4-fold increase in fruit Ca levels from 450 ppm in the control to 2260 ppm. The addition of a thickener to the $CaCl_2$ dipping solution was previously found to enhance Ca uptake in apples (9, 11). Mason et al. (11) concluded that a thickener solution caused more dipping solution to adhere to the surface of the fruit which resulted in greater Ca uptake by the fruit.

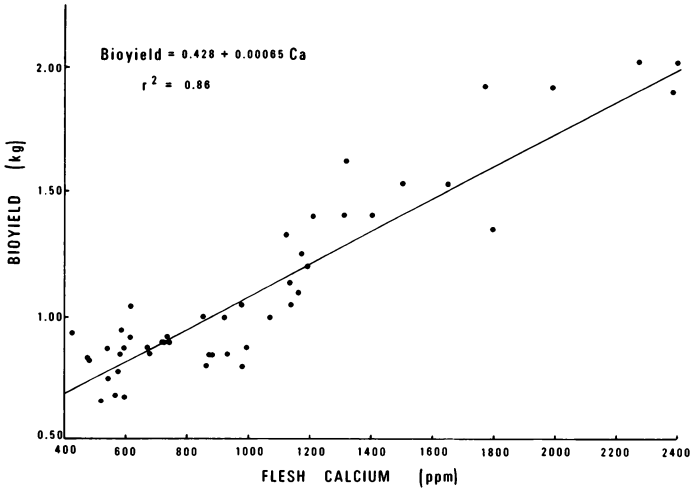


Fig. 4. Effect of flesh Ca on bioyield in 'Van' cherry.

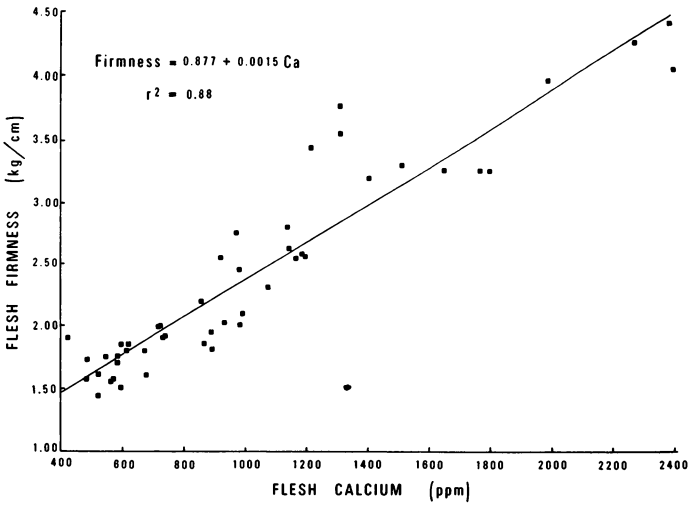


Fig. 5. Effect of flesh Ca on fruit firmness in 'Van' cherry.

Fruit firmness and bioyield showed similar positive correlations to flesh Ca concn as a result of a $CaCl_2$ dip (Fig. 4, 5). Fruit deformation to bioyield, however, was not significantly correlated ($P < 5\%$) with flesh Ca concn. Higher flesh Ca levels resulting in increased flesh firmness and bioyield determined at the end of the storage period as compared with the average value at harvest of 1.26 kg/cm for the dipped control fruit values. This phenomenon of increasing firmness is different from the Ca effect in retarding the loss of firmness in stored apples (10). Increased flesh Ca levels created by raising $CaCl_2$ or thickener concn in the dipping solution resulted in proportionately higher fruit firmness and bioyield readings.

Dipping cherry fruits for 0.25 min increased fruit Ca content by 170 and 440 ppm for $CaCl_2$ solutions without and with 2.5 g/liter thickener added, respectively. The data of Fig. 3 indicates that flesh Ca levels were increased by prolonging the contact time of the fruit with the dipping solution and corresponding increases in fruit firmness and bioyield values resulted. The actual fruit firmness and bioyield values (Table 1, 2) show a general relationship to the values predicted from flesh Ca levels in Figs. 4 and 5. However, fruit firmness values appeared to be greater than the predicted values from Ca levels for the 4 hr dip (Table 2). This suggests that prolonged soaking time may increase fruit firmness irrespective of the effect of Ca.

The infusion of Ca into flesh tissues may have increased bioyield and fruit firmness values by preventing the solubilization

Table 1. Effect of dipping time on fruit bioyield and firmness in 'Van' cherry; no thickener in dip.

| Dip time[z] (min) | Predicted bioyield (kg) | Actual bioyield (kg) | Predicted firmness (kg/cm) | Actual firmness (kg/cm) |
|---|---|---|---|---|
| No dip | 0.76 | 0.80 | 1.66 | 1.67 |
| 0.25 | 0.88 | 0.85 | 1.91 | 1.77 |
| 10 | 0.99 | 0.88 | 2.18 | 2.05 |
| 60 | 1.05 | 1.00 | 2.32 | 2.41 |
| 120 | 1.08 | 1.04 | 2.37 | 2.46 |
| 240 | 1.16 | 1.13 | 2.56 | 2.73 |

[z]Dip solution contained 40 g/liter (70%) $CaCl_2$, 1 ml/liter non-ionic surfactant, 0.5 g/liter Benlate.

Table 2. Effect of dipping time on fruit bioyield and firmness in 'Van' cherry; thickener in dip.

| Dip time[z] (min) | Predicted bioyield (kg) | Actual bioyield (kg) | Predicted firmness (kg/cm) | Actual firmness (kg/cm) |
|---|---|---|---|---|
| No dip | 0.76 | 0.85 | 1.66 | 1.73 |
| 0.25 | 1.05 | 1.00 | 2.32 | 2.11 |
| 10 | 1.06 | 0.98 | 2.34 | 2.25 |
| 60 | 1.13 | 1.18 | 2.49 | 2.67 |
| 120 | 1.20 | 1.18 | 2.67 | 2.66 |
| 240 | 1.27 | 1.32 | 2.82 | 3.50 |

[z]Dip solution contained 40 g/liter (70%) $CaCl_2$, 2.5 g/liter Keltrol, 1 ml/liter non-ionic surfactant, 0.5 g/liter Benlate.

of Ca and by the formation of additional Ca cross-linkages between the polygalacturonic acid chains (1) which are largely responsible for the cementing features of the middle lamella (5). McCready and McComb (12) suggested that Ca could form a Ca pectate gel within cherries. A greater resistance to cell rupture and shearing between adjacent cells would result from a Ca fortified middle lamella thereby providing increased bioyield and firmness values.

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# Factors Affecting Rabbiteye Blueberry Seed Germination[1]


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*Additional index words. Vaccinium ashei,* seed size, aerodynamic separation, light



*Abstract.* **Blueberry seeds (*Vaccinium ashei* Reade cv. Tifblue) were aspirated into several terminal velocity (TV) grades in an elutriation column. Different light and temperature environments were used to germinate the seeds. In all tests, germination was best at TV grades 2.23 and 2.45. Seed remaining in the air columns after aspiration did not germinate. Light was necessary for germination.**


Rabbiteye blueberry seeds usually require 6 to 8 weeks to complete germination and sometimes require up to 12 weeks (6). This presents a problem to blueberry breeders. Scott and Ink (10) have shown that after-ripening of highbush blueberry seeds improves seedling emergence; however, Hall et al. (7) reported 80% germination of lowbush blueberry seeds when the seeds were not dried before planting. Scott and Draper (11) found that seed stored at 4°C for 6 months, then sown in light, had an average germination of 39% at the end of 6 weeks with no additional germination up to 16 weeks and no germination in the dark. Stushnoff and Hough (14) reported that maximum germination of highbush blueberry seeds was obtained with alternating diurnal greenhouse temp and red filtered light, following after-ripening at alternating temp. Lowbush blueberry seed stored at −23°C either in fruit or as dried seeds germinated well (1). Darrow and Scott (5) noted that rabbiteye seed germinated much quicker than highbush seed.

Germination and seedling vigor have been closely associated with performances of several crops (3, 12, 13, 15, 16). Larger and more uniform seed generally produces more uniform germination and larger yields. The purpose of this study was to determine the germination response of rabbiteye blueberry seed segregated based on differences in their terminal velocity.

### Materials and Methods

Open-pollinated 'Tifblue' blueberry fruit were harvested July 1976 and stored at −25°C for about 90 days. Seeds were extracted using the method of Morrow et al. (9). The best extraction was achieved by placing 25 berries in 100 ml of water and blending the mixture in a Waring blendor for 35 sec. Seeds were air dried, placed in paper envelopes and stored at room temp.

The following seed sizing procedure was used: A seed sample


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