

recommend application of no more than 6 ounces per 100 gallons in the first application, and suggest that 4 or 5 ounces per 100 gallons may be more appropriate. The amount of product that you actually apply will depend upon the tree row volume (TRV). For example, if you decide to apply 6 ounces per 100 gallons of spray on a block with a TRV requiring 200 gallons per acre in a dilute spray, you would apply 12 ounces of Apogee per acre. Rates between 2 to 4 ounces per 100 gallons dilute spray should give adequate growth control in subsequent applications. While we frequently suggest that growth regulators should be applied as a dilute spray, Apogee has been very effective when applied in water volumes less than TRV, as long as the appropriate rate per acre is maintained and good coverage is achieved. Water volumes below 50 gallons per acre are not recommended.

Apply with a Surfactant. Absorption and performance of Apogee are improved if a surfactant is included with each application. No one surfactant has been identified as being best, but Regulaid, LI-700, Induce, and Triton B 1956 have been consistently effective. Generally, a surfactant rate of 1 pint per 100 gallons assures good wetting and coverage.

Use a Water Conditioner. Apogee may precipitate out of the spray solution, thus becoming ineffective, if it is applied in spray water that is too hard. Further, the addition of a water conditioner may improve the growth-retarding effect of Apogee, regardless of water hardness. Ammonium sulfate should be used with equal weights of Apogee. Alternatively, 2 pints of either of the water conditioners Quest or Choice can replace one pound of ammonium sulfate.

Precautions when Using Apogee.

Apogee may increase fruit set. This response is particularly pronounced in the Northeast and is linear with increasing Apogee rate. Application of Apogee at petal fall should be restricted to rates below 6 ounces per 100 gallons to minimize effect on increasing fruit set. A more aggressive thinning program will be necessary on blocks that receive Apogee.

Interactions may occur with gibberellin-containing products. Apogee may reduce the

effectiveness of Provide when this product is applied to apples to reduce fruit russetting. However, Apogee does not appear to influence the efficacy of Promalin when used to improve the shape of apples or to modify the response of Accel when applied as a thinner on apples.

Apogee may cause fruit cracking on Empire apples. Although this is not noted every year or in all locations, the response is sufficiently consistent and severe to suggest it should not be used on this cultivar. Fruit cracking has also been noted on Stayman when grown in the mid-Atlantic region.

Use of Apogee to Control Fire Blight. Apogee will control fire blight on shoots by inducing resistance in the tree, although the exact mechanism is still unknown. For it to be effective, Apogee must be applied, and growth retardation must occur, before infection. Generally this requires that application must occur a minimum of 10 to 12 days before infection. The active ingredient in Apogee appears not to have any direct effect on the fire blight bacteria. It is not effective on blossom blight, so traditional measures using products labeled for control of the blossom phase are appropriate.

Application of Apogee to control fire blight should be made at the same time as applications to control growth, when shoots are 1 to 1.5 inches in length, and at a rate of 6 ounces per 100 gallons. Higher rates are not recommended because of complications associated with increased fruit set. A second application at the 2 to 4 ounce rate two to three weeks later will be necessary. If signs of bud break are seen later in the summer, a third (or more) application(s) at 2 to 3 ounces per 100 gallons should be made.

CALCIUM FOLIAR SPRAYS and POSTHARVEST DIPS

Calcium (calcium chloride or calcium nitrate) tree sprays have been shown to increase the calcium content of the fruit, and to reduce fruit problems that are associated with inadequate calcium: bitter pit, scald, breakdown, and rot. Foliar sprays should begin about 3 weeks after petal fall and be repeated at

Table 27 – Calcium materials for use on apples

Product name	Percent elemental calcium	Pounds calcium per gallon or pound	Manufacturer	Product amount per acre per spray (min. - max.)	Pounds calcium per acre per spray (min. - max.)
CaB	6.0	0.60	Stoller, Inc.	3–6 pts.	0.22–0.45
CaB'y	10.0	1.19	Stoller, Inc.	2–4 qrts.	0.58–1.19
<i>Calcium chloride (77–80% CaCl₂)</i>	27.8	0.28	many	1.8–6.2 lbs.	0.50–1.74
Calcium chloride (35% CaCl ₂)	12.6	1.42	many	0.35–1.24 gals.	0.50–1.76
<i>Cor-Clear Dry</i>	34.5	0.34	SEGO Intl.	4–8 lbs.	1.36–2.72
Foliar Ca. Folical	10.0	0.96	Agrimar Corp.	1 gal.	0.96
Fung-Aid	10.0	1.19	Stoller, Inc.	2–4 qrts.	0.58–1.19
Link Calcium 6%	6.0	0.62	Wilbur-Ellis Co.	2–4 qrts.	0.31–0.62
<i>Mora-Leaf Ca. (94% CaCl₂)</i>	34.0	0.34	Wilbur-Ellis Co.	4–8 lbs.	1.36–2.72
Nutri-Cal 8% Calcium Solution	8.0	0.89	CSI Chem. Corp.	1–2 qrts.	0.22–0.44
<i>Nutra-Phos 12</i>	11.0	0.11	Pace Intl. LP	3–10 lbs.	0.33–1.1
<i>Nutra-Phos 24</i>	20.0	0.20	Pace Intl. LP	3–10 lbs.	0.60–2.0
<i>Nutra-Phos 28</i>	28.0	0.28	Pace Intl. LP	0.84–2.8 lbs.	0.30–1.0
Nutra-Plus Cal-Gard	6.0	0.60	Custom Chemicides	1–3 qrts.	0.15–0.45
<i>Pit-Stop Dry Con. Foliar Cal. 32.5%</i>	32.5	0.32	Ag-Chem, Inc.	4–8 lbs.	1.28–2.56
Pit-Stop Foliar Calcium 12%	12.0	1.35	Ag-Chem, Inc.	1.5 gals.	2.02
Sett	8.0	0.91	Stoller, Inc.	1 gal.	0.91
Sorba-Spray Cal.	8.0	0.86	Pace Intl. LP	1–4 qrts.	0.21–0.86
Sorba-Spray CaB	5.0	0.50	Pace Intl. LP	1–4 qrts.	0.12–0.50
Stopit Ca. Conc.	12.0	1.28	Pace Intl. LP	2–4 qrts.	0.64–1.28
Tracite Ca. 6%	6.0	0.60	Helena Chem Co.	3–6 pts.	0.22–0.45
Traco Pit-Cal Liquid Calcium	12.0	1.40	Traylor Chem Co.	0.5–2 gals.	0.7–2.8
Wuxal Calcium	10.7	1.42	Aglukon Div.	3–4 pts.	0.53–0.71

Table 27 and associated text adapted from: 1998–1999 *Pennsylvania Tree Fruit Production Guide*. R.M. Crassweller, Horticulture Section Coordinator; C.M. Felland, Production Guide Coordinator. Names in italics are dry formulations, all others are liquids.

about 2-week intervals until harvest, totaling about 6 or more applications per season.

Technical grade CaCl₂ (77 to 80% CaCl₂) should be applied at the rate of 2 to 2.7 lbs./100 gals. dilute until mid-July and at the rate of 2.7 to 3.3 lbs./100 gals. dilute after mid-July.

Ca(NO₃)₂ may be substituted for CaCl₂ but must be applied at the rate of 3.2 to 4.3 lbs./100 gals. dilute until mid-July and at the rate of 4.3 to 5.3 lbs./100 gals. dilute after mid-July. We have tested Ca(NO₃)₂ only on McIntosh, and have experienced no fruit injury; however, there are reports that Ca(NO₃)₂ causes fruit spotting on Delicious and Golden Delicious. We have measured no increase in leaf nitrogen levels from the recommended dosage of Ca(NO₃)₂.

If CaCl₂ is applied apart from pesticides, a non-ionic wetting agent should be added. The wetting

agent may reduce the potential for leaf injury and increase uptake. Since most pesticide formulations include wetting agents, none should be needed when CaCl₂ and pesticides are combined. Leaf injury may be enhanced by the addition of captan or Guthion to the CaCl₂ spray, but most pesticides are compatible with CaCl₂.

Injury appears as a burn at the margins of the leaves. We feel that in most cases this injury is associated with inaccurate sprayer calibration, since the injury is not as prominent when dilute applications are used. Concentrations up to 10X have been very effective, but any inaccuracy in calibration can affect the actual application rate dramatically and result in leaf burn. To reduce the risk of injury to the fruit and foliage, Washington State Cooperative Extension recommends applying CaCl₂ with at least 100 gallons of spray water per acre.

CaCl₂ should be mixed in a pail of water and be added last, when the sprayer tank is nearly full, to ensure thorough mixing.

There must be sufficient agitation to maintain thorough mixing during application. Risk of damage is greatest on weak trees and injured foliage.

We are not aware of any incompatibility of CaCl₂ with commonly used pesticides, but formulations and combinations frequently change, so users should be alert to any unusual behavior of materials in spray mixtures. Under cool, moist conditions, use caution when applying foliar calcium as part of a complex tank mix. Slow drying may increase absorption and increase risk of injury.

Do not tank mix CaCl₂ with Solubor or Epsom salts. Do not apply CaCl₂ at temperatures above 80°F.

Table 28 – Calcium Foliar Spray Rates

Applications should begin 3 weeks after petal fall and continue at 2-week intervals until harvest.

Calcium Source	Rates per 100 gal. dilute	
	Until mid-July	After mid-
Calcium chloride*	2 to 2.7 lbs.	2.7 to 3.3 lbs.
Calcium nitrate	3.2 to 4.3 lbs.	4.3 to 5.3 lbs.
Elemental calcium	0.6 to 0.8 lbs.	0.8 to 1.0 lbs.

* Add 2/3 fl. oz. vinegar per pound of CaCl₂. Use of surfactant in CaCl₂ spray may reduce potential for foliar injury.

The initial pH of technical CaCl₂ in water is about 10.3, because small amounts of free calcium oxide are present and form calcium hydroxide in the water. This high pH may reduce effectiveness of some pesticides. We therefore recommend adding 2/3 oz. of vinegar (5% acid content) per lb. of CaCl₂ to neutralize the alkalinity and bring the spray solution to about pH 6.0. Addition of vinegar does not affect uptake of Ca by the apples. Materials that will buffer the solution to about pH 6.0 may also be used as an alternative to vinegar. Since Ca(NO₃)₂ does not raise the pH of the spray solution, vinegar is not required.

Soil management, pruning practices, crop load, and other nutrients have an impact on fruit disorders and fruit storability. Consult the *New England Apple*

Production Guide (W.R. Autio, ed., Cooperative Extension of New England states) for more information on these subjects.

Selecting a Calcium Formulation

There are many commercial products containing calcium (Table 27). These include liquid formulations that are convenient to use, eliminating the need to pre-mix flake calcium chloride before it is added to the spray tank. In addition, vinegar may not be needed to maintain an acidic spray solution with many of these products. Per pound of actual calcium, however, these prepared formulations are no more effective than flake calcium chloride.

Determining the Amount of Elemental Calcium in a Commercially Formulated Product

- From the label, determine the percentage of elemental calcium in the product.
- For a liquid formulation, multiply the percentage by the weight of the material per gallon. For a solid, multiply the percentage by the weight of the material you will add to the tank. This gives the amount of elemental calcium per gallon or pound.
- Determine the amount of formulated material you will apply per acre per application. Multiply this by the number of applications to get the total amount that you will use per acre for the season.
- Multiply the elemental calcium per gallon or pound times the amount used per season to get the total amount of elemental calcium for the season.
- Compare this amount with the recommended 4 to 14 lbs. of elemental calcium per acre per season.

POSTHARVEST CALCIUM DIPS

Postharvest dips or drenches of calcium chloride can be used to increase the calcium content of apples and reduce the incidence of storage disorders related to calcium deficiencies.

Materials containing calcium chloride are the only calcium sources that may be used. Calcium chloride at 94% purity or higher may be used, and we recommend its use at no more than 12 lbs./100 gallons of water, since damage to the fruit may occur at higher concentrations. We recommend inclusion of 8 to 10 fl. ozs. of 5% vinegar per 100 gallons to counteract the alkalinity of the calcium chloride solution.

Two commercial sources of calcium chloride in

liquid formulation are also labeled for use. “STOPIT” liquid calcium concentrate (Shield-Brite Corp.) (12% calcium) is labeled for use at 1 gallon per 74 gallons of drench water. “Decco Calcium Chloride-EC 405” (12% calcium) is labeled for use at 1 gallon per 79 gallons of drench water. Both of these labelled rates of use provide markedly lower calcium concentrations in the solution than does 12 lbs. of calcium chloride (94%) per 100 gallons. However, their formulations make them easier to use than 94% calcium chloride pellets.

All of these calcium materials may be combined with scald-inhibiting chemicals. No postharvest dip or drench should be used without inclusion of fungicide to control postharvest rotting.

POSTHARVEST ROTS

See Part I: *Other Apple Diseases - Postharvest rots*

CHEMICAL CONTROL OF WATER SPROUTS AND ROOT SUCKERS

Water sprouts are vigorous shoots arising from any aboveground part of the tree. Suckers are shoots which originate from roots.

Water sprouts and suckers can be controlled with a formulation of naphthaleneacetic acid (NAA). The formulation is sold by the trade name, Tre-Hold Sprout Inhibitor A 112, and is registered for use on bearing and non-bearing apple and pear trees. **The restricted entry interval for Tre-Hold is 12 hours.**

WATER SPROUT CONTROL. This treatment can be applied any time during the dormant season before buds begin to grow. Use 10 fluid ounces (2/3 pint) of Tre-Hold A 112 and make up to volume of 1 gallon with a combination of water and interior grade white latex paint. The latex marks the treated area, and thickens the mixture, restricting drip onto untreated areas. At least 1/2 gallon of latex paint should be used in each gallon of final mix. Oil based paints injure tree bark, and some exterior grade latex paints may also do some damage to bark.

After pruning, treat the bark and cut surfaces thoroughly in areas where vigorous shoot growth would be expected. Do not treat large portions of the

tree or fruiting wood, as fruit size reduction may occur. Treatment applied to buds may kill them, so avoid dripping mixture onto other parts of the tree.

Apply the NAA/latex paint mixture using a paint brush or small compressed air sprayer. (A sponge attached to the nozzle is useful for swabbing the mixture on pruning cuts.)

ROOT SUCKER CONTROL. To avoid possible fruit thinning, delay application of Tre-Hold to growing suckers until 4 weeks after petal fall. Prepare the mixture as for water sprout control, or you may wish to reduce or eliminate the latex paint and substitute an equal amount of water. Control is most effective when shoots are growing actively. If suckers are pruned back during the dormant season, or a little later, new growth may be easier to treat without accidental application to tree foliage.

Besides proper timing, the most important consideration is thorough coverage of all sucker shoots (foliage) in the treated area. Interference from weeds will reduce effectiveness of the treatment. Use of a contact herbicide about two weeks prior to NAA treatment may be helpful. Repeat annual application of Tre-Hold NAA may be needed for continued sucker control.

Take all necessary precautions to avoid spray drift onto desirable foliage. Do not apply when temperature exceeds 85°F, as volatile NAA can cause leaf damage or fruit ripening.

ETHEPHON TO PROMOTE RED COLOR and RIPENING

Ethephon, sold as Ethrel, releases ethylene, a natural growth regulator. Ethylene stimulates ripening in fruits that have reached a certain minimum stage of maturity. Several changes accompany ripening of apples, including the following: They become softer; an abscission zone develops between fruit stem and spur; starch in the fruit is converted to sugars; internal production of ethylene increases; and the rate of respiratory heat production increases. In McIntosh and some other cultivars, the ability to develop red color in the fruit skin is stimulated as a ripening response. Use of ethephon will advance development of all the maturity-dependent changes.

Stimulated ripening may be desirable where fruit is needed for early fresh market, for increasing