Growth-Regulating Chemicals

Apply growth-regulating chemicals at a rate determined by tree row volume (TRV). Because there is inadequate information on compatibility, apply these chemicals only as a separate spray unless specific compatability is stated on the label for a particular growth regulator. Growth regulators should not be applied during periods of extremely high or low temperature or moisture stress.

Promalin (*benzyladenine, BA; + gibberelin, GA_{4+7}*)

If promalin is applied later than full bloom, only late blossoms and fruit that will drop off or be chemically thinned will respond. Do not apply promalin to runoff. Promalin is approved for tank mixing with streptomycin and bloom fungicides.

Goal	**Chemical**	**Rate and Time of Application**
To improve shape and increase fruit weight of Delicious apples.	Promalin [*benzyladenine* (BA) +*gibberellin* (GA_{4+7})]	1 to 2 pints/100 gal of water; between king bloom opening and full-bloom stage as a fine mist at 40 to 50% of TRV calculated dilute water volume.
To increase lateral bud break and shoot growth and improve branch angle on 1-year-old wood on nonbearing trees.	Promalin + surfactant	1 to 2 pints/10 gal (250 to 500 ppm) and surfactant at 2.5 oz/10 gal. Apply to previous season's leader growth with thorough coverage when new growth is 1 to 3 inches long.
	Bagging + Promalin without surfactant	Bag previous season's unbranched central leader growth 3 to 4 weeks before anticipated bud break to promote greater branching with a bag or sleeve of 2- to 4-mil clear polyethylenet. Fold around the leader and fastened tight with a clothespin at the bottom and the top; leave on until the growth in the bag is 1 to 2 inches long (usually about bloom time). Daytime temperatures should be monitored carefully to prevent overheating of the foliage inside the bag. However, some leaf scorch is acceptable.
		Lower bag closure should be loosened for 2-4 days before bag is removed. Upon bag's removal, the leader should be sprayed with a 250-ppm application of promalin as described above.
To promote lateral branching on current season's terminal growth.	Promalin without surfactant	Use 8 ounces/10 gal (125 ppm). Apply after every 8 to 10 inches of terminal growth in conjunction with removal of at least one-half of each immature terminal leaf without damaging the growing point or bud (i.e., summer knipping).

Pro-Vide (*gibberelin, GA_{4+7}*)

Timing of the application is important. Apply Pro-Vide as a fine mist in no less than 100 gallons of water per acre or approximately 40 to 50 percent of TRV. Pro-Vide is approved for tank mixing with pesticide applications.

Goal	Chemical	Rate and Time of Application
To reduce russet formation caused by weather conditions on susceptible cultivars (esp. Golden Delicious).	Pro-Vide (GA_{4+7})	Four applications at 10-day intervals at a rate of 10 ounces/acre /application in 100 gal of water are necessary for optimal response. Make first application at petal fall. Do not exceed 40 ounces/acre/year. Apply as a fine mist.
To reduce fruit cracking (esp. Stayman).	Pro-Vide	Use 1 to 2 pint/100 gal of water; apply at 50% TRV at 3-week intervals beginning in early June or as soon as significant cracking is observed. Use with surfactant at 0.5 pint/100 gallons.

Chemical Fruit Thinning Sprays

Because of variability of chemical thinner response, it is recommended that growers use all thinners on a trial basis until they become experienced. If seed numbers are small, trees are weak, or the weather is cool and cloudy, use lower concentrations of thinner chemicals. Also remember that young trees are generally easier to thin than mature trees. Ball all thinner applications on average fruit diameter. Determine average fruit diameter by measuring all growing fruitlets per cluster. Sample randomly selected clusters throughout the tree canopy and orchard. At least 100 fruitlets should be measured to calculate average diameter. All hand-gun applications should be made to the point of runoff at a rate of chemical use that is one-third to one-half the rate recommended for an airblast application. NOTE: The use of spray oils required with certain other pesticides (eg. Agri-Mek) applied in some unknown proximity to thinner applications will interact and increase thinner activity.

Fruitone N (*naphthalene-acetic acid, NAA*)

The time of application for optimum thinning with NAA (Fruitone-N) or NAA plus carbaryl (Sevin) is 7 to 9 millimeters average fruitlet diameter for Red Delicious cultivars and up to 12 millimeters with Golden Delicious. Under optimum growing conditions NAA thinner applications usually occur 14 to 21 days after full bloom. NAA must be applied at the proper fruit size; otherwise, thinning may be reduced, stunted fruit (nubbins) may remain on the tree, or both. Using NAA at rates above 5 parts per million on Red Delicious may cause excessive nubbining and half-grown fruit to stick on the tree to harvest. The Fruitone-N formulation of NAA provides 2 ½ parts per million per 100 gallons for each ounce of Fruitone-N product used.

Sevin (*carbaryl*)

All formulations of carbaryl have equal chemical thinning activity. Where carbaryl is used for chemical thinning at petal fall only the "XLR Sevin" liquid formulation should be used because it is safer around bees than the WP formulations. Carbaryl has thinning activity on Golden Delicious. However, occasional fruit russetting may result. The XLR formulation has 0.5 pounds active ingredient per pint. Late use of carbaryl for thinning purposes may be detrimental to an integrated mite management program and should be avoided, especially on Red Delicious.

Ethrel and Sevin *(ethephon and carbaryl)*

Combinations are not suggested for standard or nonspur Red Delicious cultivars because excessive thinning is likely to occur. For thinning spur Red Delicious, note that the thinning effect of ethephon and carbaryl (Ethrel and Sevin) is not translocated from nonfruiting spur and leaves to the fruiting spurs; thus, for applications to be

effective, the fruit and leaves of fruiting spurs must be completely covered. An Ethrel-Sevin tank mix for chemical thinning is recommended only as a dilute application (1X) using a water volume accurately calculated with the "tree row volume" formula. Concentrate applications are generally stronger and very erratic in thinning response. To obtain uniform thinning throughout the tree, the spray delivery pattern must be adjusted on an airblast sprayer to deliver 80 to 90 percent of the spray volume to the top third of the tree canopy. This nozzling adjustment ensures adequate coverage of fruiting spurs in the top portion of trees and helps avoid overthinning in the lower and internally shaded portions of trees. Ethrel-Sevin thinning applications may be used between 12 and 18 millimeters average fruit diameter; however, applications should be made early in the size range (12 to 15 millimeters) unless adverse weather delays application. Because rainfall and cloudy weather can have an effect on thinner activity, Ethrel-Sevin applications should not be made less than 48 hours before an imminent cloud and rain event, or closer than 12 hours after a significant rainfall (0.5 inch or more). Persistent cloudiness, light mist, rain or all three after application may increase thinning activity; a hard rain within 8 to 10 hours after application may reduce thinner activity by wash off.

Goal	**Chemical**	**Rate and Time of Application**
To defruit trees too young or too small to begin bearing (all varieties).	Fruitone N + Sevin + Ethrel	2 oz Fruitone-N + 1 lb a.i. Sevin + 2 pts of Ethrel per 100 gal applied at 8 to 10 mm fruit diameter. **Caution**: Application will temporarily suppress vegetative growth (3 to 4 weeks).
To chemically reduce fruit load on bearing trees for improved fruit size and return bloom.	See fruit thinning chart on following page.	
[1]To increase return bloom for the following season, especially on heavily cropped trees.	Fruitone N	5 ppm, or 2.5 ppm + surfactant. After the chemical fruit thinning activity window is past (typically 6 weeks past petal fall) use biweekly applications of NAA in the next 3 to 4 cover sprays. (Typically 2 in June and 2 in July for Southeastern U.S. apple-growing areas). These NAA applications may be tank mixed in pesticide cover sprays.

[1]This response is effective on slightly to moderately over-cropped trees (125 to 200 percent of full crop), but will not be effective on excessively over-cropped trees.

Apple Thinning Recommendations for the Southeast

Thinner Activity	Chemicals/Combinations rate per 100 gal	Fruit Size avg-mm	Gala, Goldrush, Granny Smith, Jonagold, etc.	Red Del.		Gold Del.	Rome		Fuji	Rethin all Varieties
				Std	Spur		Std	Spur		
least	Sevin 0.5-1 lb. ai	7 to 9	X	X			X			See rethinning table below
	Sevin + surfactant 0.5 - 1 lb. ai + 0.5 - 1 pt	7 to 9	X	X			X			See rethinning table below
	Sevin 0.5 - 1 lb. ai	petal fall			X			X		
	Accel + Sevin 30 grams + 0.5 - 1 lb. ai	6 to 8							X	
	Sevin + Fruitone N 0.5 - 1 lb. ai + 2.5 - 5 ppm	7 to 9	X	X	X nubbin possible		X	X	Use no Fruitone on Fuji	
	Fruitone N 5 - 25 ppm	9 to 12				X				
	Fruitone N = surfactant 5 - 15 ppm + 0.5 - 1 pt	9 to 12				X				
	Sevin + spray oil 0.5 - 1 lb. ai + 0.5 - 1 pt	6 to 9			X			X		
	Sevin + Ethrel + Fruitone N 1 lb. ai + 0.5 - 0.75 pt + 2.5 ppm	9 to 11 18 to 30 for rethinning easy to thin varieties			X			X		See rethinning table below.
	Sevin + Ethrel 1 lb. ai + 1.5 pts	12 to 18			X			X	X	
	Sevin + Ethrel + Fruitone N 1 lb. ai + 1.5 pts +/- 5-10 ppm	18 to 30								See rethinning table below.
most	Sevin 1 lb. ai @ followed by Accel 20-30 gr @ followed by Sevin + Ethrel @	petal fall 6 to 9 2 weeks later if needed						X X X	X X X	

WARNING: Use of spray oils as required with certain pesticides (such as Agri-Mek) applied in proximity to thinner applications will interact and increase chemical thinner activity.

a.i. = active ingredient.

Apple Rethinning Recommendations for the Southeast

Thinner Activity	Chemicals/Combinations (rates per 100 galons)	Timing of application	Rethinning (all varieties)
least	Sevin .5 - 1 lb ai	7 to 10 days after first thinner application	If needed to push weak/stunted fruit off , esp. on *Golden Delicious*
	Sevin + surfactant .5 - 1 lb ai + .5 - 1 pt	14+ days after first thinner application	Rome, Std. Reds, Mutsu, GoldRush, Jonagold, etc.
	Sevin + Ethrel ± Fruitone N 1 lb ai + .5 - .75 pt ± 2.5 ppm	18 to 30 and at least 14 days after first application	On moderately overcropped trees (150-200% crop load), esp. on easy-to-thin varieites
most	Sevin + Ethrel ± Fruitone N 1 lb ai + 1.5 pt ± 5 - 10 ppm	18 to 30 - and at least 14 days after 1st application	Heavy to excessive over-cropped trees (250%+) - esp. spur type varieties

Apogee (*prohexadine-calcium)*

Apogee (prohexidione calcium) reduces terminal growth by inhibiting synthesis of gibberellins, which regulate shoot growth in apples. Once applied, it requires between 10 and 14 days for Apogee to slow growth. Apogee degrades within the trees in a few weeks, so repeat applications will be necessary to maintain growth control throughout the whole growing season. **Applications must be continued as long as the potential for shoot growth is present**, but remember the preharvest interval is 45 days.

Amount to Apply: The label suggest rates of application between 3 and 12 ounces **per 100 gallons** of dilute spray (62.5 to 250 ppm). The **amount you apply per acre** depends on your tree row volume (TRV). While it is frequently suggested that plant growth regulators should be applied dilute, Apogee has been used very effectively when applied in water volumes less than TRV, as long as the a.i. per acre is maintained based on TRV and uniform coverage is achieved. Water volume below 50 gallons per acre is not recommended.

Time of Application: It is essential to make the first application when terminal shoots are no longer than 1 to 3 inches. This usually coincides with late bloom or petal fall. Satisfaction from the use of Apogee will depend upon making the first application on time. There is no detrimental effects on bees, so the first application can be made even before the bees are removed from the orchard.

Surfactants: To assure good wetting and coverage, use surfactant at a rate of 1 pint per 100 gallons with Apogee.

Use of Apogee on trees sprayed with Promalin, Pro-Vide, or both. Promalin and Pro-Vide are gibberellin-containing products that are applied in the bloom or postbloom period to improve fruit shape and reduce fruit resetting, respectively. Apogee inhibits gibberellin production in apple trees. Some data suggest that the response to these gibberellin-containing products may be reduced on Apogee-treated trees. This has not been proven, but the possibility exists.

Use of Apogee to Control Fire Blight: Apogee will control fire blight on shoots by inducing resistance in the tree. The growth retardation response must have occurred **before** fire blight infection for it to be effective. Generally, this will require a minimum of 10 to 12 days before infection to be effective. The active ingredient in Apogee does not have any direct effect on the fire blight bacteria and it is not effective on blossom blight, so traditional control measures using streptomycin are necessary. Apply Apogee to control fire blight with applications that are made to control growth (when shoots are 1 to 2 inches in length) or no later than petal fall. Whether the 3 to 6-ounces-per-100-gallons rate used for growth control is as effective for fire blight control as a 12-ounces-per-100-gallons rate has not been determined for Southeastern orchard conditions.

Goal	Chemical	Rate and Time of Application
To reduced vegetative growth, and to reduce later season tree canopy volume and density for improving pesticide efficiency.	Apogee	3 to 6 oz + 1 pt surfactant. Do not apply later than 45 days before harvest.[1] With early maturing cultivars, such as Gala, a post-harvest application may be necessary for season-long growth control. Apply as a sequential biweekly application beginning at 1- to 2-inch shoot growth using 3 oz/100 gal, or apply as sequential monthly applications beginning at 1 to 2 inches of shoot growth using 6 oz/100 gal. (See below table for application options.) Do NOT tank mix with calcium nutrient sprays; can be mixed in pesticide cover sprays.

[1]Maximum allowable use rate per season is a total of 99 ounces per acre.

Application Options for Apogee in the Southeast

Tree Vigor (relative to crop load, rootstock, and cultivar vigor)	Weeks after 1 to 3" of terminal growth (approx. PF)[1]						
	0	2	4	6	8	10	12
Moderate vigor	3 oz[2] **or** 6 oz	3 oz Ca[3]	3 oz 6 oz	3 oz Ca			
High vigor	3 oz **or** 6 oz	3 oz Ca	3 oz 6 oz	3 oz Ca	3 oz 6 oz	3 oz Ca	
Excessive vigor	3 oz **or** 6 oz	3 oz Ca	3 oz 6 oz	3 oz Ca	3 oz 6 oz	3 oz Ca	3 oz 6 oz
Crop loss	3 oz **or** 6 oz	3 oz	3 oz 6 oz	3 oz	3 oz 6 oz	3 oz	3 oz 6 oz

[1]Application sequences must start at 1 to 3" of new growth extension for effective response.
[2]3 or 6 oz/100 gal rates must be adjusted to rate per acre based on TRV of each orchard being treated.
[3]Ca: Calcium applications, if used, cannot be tank mixed with Apogee.

Sucker Control

Apply as a low-pressure, large-droplet (to prevent drift up into the tree), directed-spray application at base of tree with handheld equipment. A thorough application, giving complete wetting and coverage, is necessary for good results. Do not allow spray to drift onto tree foliage or fruiting spurs. For best results, cut woody sucker growth at ground level during the dormant season and apply Tre-Hold when new sucker growth is 4 to 12 inches long. (Do not apply during the period from bloom to 4 weeks after bloom.)

Goal	Chemical	Rate and Time of Application
To control suckers from the ground around the trunk of apple trees.	Tre-Hold A-112 *(NAA, ethyl ester*)	Use 10,000 ppm concentration (10 oz/gal). Apply after dormant removal of suckers and when new sucker growth is 4 to 12 inches long.

Water Sprout Control

Do not **spray** Tre-Hold up into the trees. Tre-Hold should not contact buds or fruiting spurs. Tre-Hold use is not recommended when green growth is present. One to 4 pints of light-colored latex (water-based) paint may be included per gallon to mark where application has been completed. Thorough coverage giving complete wetting is necessary for good results.

Goal	Chemical	Rate and Time of Application
To control water sprout regrowth around pruning cuts and to control water sprout growth on top of large scaffold limbs where old trees are opened up.	Tre-Hold Sprout Inhibitor A-112	Use 10,000 ppm concentration (10 oz/gal); apply with sponge or brush as a localized application to the pruning cut and before growth starts in the spring (can be mixed with latex-based paint as a marker to know which cuts have been treated).

Stop-Drop Sprays

ReTain (*aminoethoxyvinylglycine*) is at least as strong and generally a stronger fruit drop control material than preload NAA, but it also substantially delays fruit maturity. This maturity delay allows additional time on the tree for fruit to increase in size and develop natural colorization (for red varieties) without excessive loosening and without fruit becoming overly mature.

The most effective and longest lasting NAA fruit drop control is obtained by preloading the tree with small doses of Fruitone-N starting 4 weeks before the anticipated normal harvest date. Four weekly applications of 5 ppm each during the month before the normal harvest date will provide this preloading. If fruit harvest is delayed beyond the anticipated harvest date, continue the weekly 5-ppm Fruitone-N applications until harvest is completed, but do not exceed six applications, and do not use more than 30 ppm during the entire drop control season.

A single NAA application of 10 to 20 ppm applied at the onset of drop may delay fruit drop for 7 to 10 days. An additional application may be made if fruit is left for longer than 7 to 10 days or if application fails to give satisfactory control. If a second application is made, apply it 6 to 7 days after the first application to extend the holding period of the second application. It is necessary to wet the foliage thoroughly for maximum effectiveness of stop-drop sprays. Applications of higher than recommended concentrations of stop-drop chemicals may accelerate fruit maturity and reduce storage life. Late applications may give ineffective control.

Goal	Chemical	Rate and Time of Application
To delay preharvest fruit drop; delay fruit maturity; and allow time for added fruit-size increase and natural coloration of red varieties. Preloading apple trees with NAA is the most effective NAA fruit drop control.	ReTain Fruitone-N (*NAA*)	Ingredient (1 packet) per acre plus Silwet L-77 or Sylgard surfactant at 0.1% (13 oz/100 gal) 4 weeks before anticipated normal start of harvesting using 100 gal/acre or 50% of TRV. Apply Fruitone-N at weekly intervals beginning 4 weeks before date of normal anticipated harvest at the rate of 5 ppm/week. Application can be included with preharvest cover sprays.
To reduce prehavest fruit drop at or after the onset of fruit loosening or drop.	Fruitone-N	Apply at 10 ppm at first sign of preharvest fruit drop on most cultivars; 15 to 20 ppm may be required on late varieties such as Rome, Stayman, Fuji, and Granny Smith. Use full coverage, 80 to 100% TRV.

Fruit Scald Control

Fruit should be dipped or drenched in crates or bins. Treat fruit before it cools, as soon after harvest as possible and not more than 1 week after harvest. The longer treatment is delayed, the less effective it is. Do not wash or brush fruit immediately after treatment. Thorough coverage of the fruit with the inhibitor is important for satisfactory control. The inhibitor solution must be kept clean, well-agitated, and aerated. Fruit should not be dipped over 30 seconds to prevent excessive residue. Do not treat fruit more than once with the same inhibitor. Fruit wraps and waxes are available that contain scald inhibitors. There are reports of DPA causing skin browning in Golden Delicious.

Goal	Chemical	Rate and Time of Application
To reduce incidence of scald on stored apples.	DPA Concentrate (*Diphenyl-amine*[1])	2.5 pt/gal water (1,000 ppm). Apply as a dip or spray to harvested fruit.

[1]10 ppm residue tolerance.