# Apple Plant Growth Regulator Programs

## Apples - bearing

| Symptom/Behaviour | Chemical | Rate per Acre | REI | PHI | Notes |
|---|---|---|---|---|---|
| To advance maturity and promote red color | **ethephon**<br>Ethephon 2SL | 1-4 pt | 72 h | 7 d | |
| | **Notes**: To promote more color by advancing fruit maturity, ethephon (Motivate) can be applied 7 to 21 days before expected harvest, depending on cultivar and season of fruit maturity. Follow label instructions carefully. Applications to advance maturity 3 to 5 days can result in smaller fruit size and shorten the storage life of fruit not harvested at proper maturity. Ethephon may not promote color when warm weather persists late in the season. Ethephon may not improve color on poor-coloring varieties and standard strains; it is less effective on interior, shaded fruit. Caution: Ethephon promotes abscission and fruit drop. Use in combination with a preharvest stop-drop spray. Ethephon is not effective for color change on Golden Delicious or advancing maturity of Granny Smith. | | | | |

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| To decrease preharvest fruit drop, delay watercore and improve harvest maturity management | **AVG**<br>ReTain | 0.73 - 1.46 lb | 12 h | 7 d | ReTain: Apply 4 weeks before anticipated start of single pick harvest or 1-2 weeks before start of multiple pick harvest depending on harvest schedule. A spray volume of 100 gallons per acre is suggested. Adjust to ensure adequate coverage. Use with registered surfactants. |
| | **Notes**: ReTain. ReTain (aminoethoxyvinylglycine, AVG) is an inhibitor of ethylene biosynthesis in fruit tissues used to adjust harvest timing and control fruit drop registered for use on both apples and pears. Inhibition of ethylene biosynthesis in apples delays maturation and permits fruit to remain on the trees longer for better color and greater size without adverse effects on storage life. For pear growers, ReTain may help maintain fruit firmness for 7–10 days. The manufacturer recommends that ReTain be applied once 4 weeks before the anticipated beginning of normal harvest for that season based on appropriate maturity indices of untreated fruit. If fruit will be harvested using a multiple-pick schedule, ReTain should be applied once at 1-2 weeks before the start of normal harvest of untreated fruit. The recommended application rate for ReTain is 50 grams active ingredient per acre (one 0.73-lb. pouch per acre). Variety-specific rates not determined. If weather conditions are not favorable for ReTain application, apply slightly earlier to avoid problems with PHI. Tank-mixes with NAA or ethephon are discouraged because these products may counteract the ethylene inhibition produced by ReTain. Tank mixes with Biobit, DiPel, or XenTari biological insecticides are permitted. For optimum response, apply ReTain during periods of slow drying conditions to enhance uptake. Apply with sufficient water to ensure thorough wetting of the fruit, but not to runoff. Use tree row volume. Avoid overhead irrigation or cooling for at least 8 hours following ReTain application. To minimize foaming of spray mixture, fill spray tank with half the amount of water needed for the final spray volume, add ReTain (in its soluble packaging) and continue to fill tank. Add the surfactant just prior to filling the tank. Minimize agitation. Use approved surfactants at a concentration between 0.05% and 0.1% v/v (0.4-0.8 pint/100 gallons maximum). Compatibility/performance data with anti-foaming agents not available; such products are not recommended for use with ReTain. | | | | |
| To increase fruit size | **6-BA**<br>Exilis 9.5 SC | 1.3-6.4 fl oz | 12 h | 86 d | Make 2–4 applications starting at petal-fall and repeating at 3- to 10-day intervals. Apply when temperatures will exceed 65°F for a few days following application. Do not apply within 86 days of harvest. Follow all label instructions. |
| | **6-BA**<br>MaxCel | 6-32 fl oz | 12 h | 86 d | Make 2–4 applications starting at petal-fall and repeating at 3- to 10-day intervals. Apply when temperatures will exceed 65°F for a few days following application. Do not apply within 86 days of harvest. |
| To increase length of lateral bloom pedicels in short-stemmed apple varieties | **Gibberellins A4A7**<br>Novagib 5L | 125 - 250 ppm | 4 h | | Use 32 - 64 fluid ounces per 100 gal water to achieve 125 - 250 ppm. Spray in 50 - 100 gal water/acre between tight cluster and first pink. See product label for more information. **Organic** |

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| To prevent preharvest fruit drop (apples) | **NAA**<br>K-Salt Fruit Fix 800 | 4-8 fl oz | 48 h | 2 d | |
| | **NAA**<br>PoMaxa Plant Growth Regulator | See Label | 48 h | 7 d | |
| | **NAA**<br>Refine 24.2L | 4-7.6 fl oz | 48 h | 2 d | |
| | **NAA**<br>Refine 6.25L | 16-32 fl oz | 48 h | 2 d | |
| | **Notes**: NAA (K-Salt Fruit Fix, Fruitone, PoMaxa, Refine) may be used to control preharvest drop of apples. NAA does not actually re-tighten the pedicel (fruit stem) after application, but retards the development of the abscission layer between the pedicel and the spur. Experimental evidence shows that NAA sprays are best applied alone and are more effective at dilute concentrations. Application timing of NAA products to control preharvest drop of apples is critical. Generally, NAA should be applied 7 to 14 days prior to planned harvest, but no closer than 2 to 5 days before harvest. NAA becomes effective for reducing fruit drop 3 to 4 days following application and has an effective period of 2 weeks. NAA has been applied as a stop-drop for apples by aircraft in those cases where it is not possible or desirable to make ground-based applications. By aircraft, the rate used is 0.25 to 0.5 pint of NAA 800 per acre. See manufacturer's label for specific recommendations as products may differ. NAA does not completely suppress fruit ethylene production; NAA-treated fruit may show evidence of changes in skin color and/or flesh softening during the interval between application and harvest, even though the typical climacteric ripening response may not be observed and fruit drop is reduced. Growers should frequently monitor both fruit maturation and fruit loosening following NAA application. Careful attention to these possible changes can help growers take advantage of reduced fruit drop while minimizing the risk of losses at harvest and/or of problems after storage. | | | | |
| To promote longer, typy Red Delicious | **Gibberellins A4A7 + BA**<br>Perlan | 1 - 2 pt | 4 h | none listed | |
| | **Gibberellins A4A7 + BA**<br>Promalin | 1 - 2 pt | 4 h | none listed | |
| | **Notes**: "Type" of Red Delicious is generally defined by the Length/Diameter (L/D) ratio of the fruit. Perceived improvements of "typiness" can be due to relatively long and/or relatively narrow fruit. Research trials in WA have shown that improvements in Red Delicious L/D ratios from use of Promalin or Perlan are often due to reduced fruit diameter rather than increased fruit length. Growers concerned about production of small fruit should be careful with use of these products. | | | | |

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| To promote return bloom | **ethephon**<br>Ethephon 2SL | 0.5-3 pt | 72 h | 7 d | |
| | **NAA**<br>PoMaxa Plant Growth Regulator | 2-8 fl oz | 48 h | 7 d | |
| | **NAA**<br>Refine 6.25L | 1.2 - 4.8 fl oz | 48 h | 2 d | |
| | **Notes**: Young trees that are slow to bear or mature trees that produce only a limited number of flowers in off years may be helped by applications of ethephon (Motivate). Delay ethephon application until at least 5–6 weeks after bloom (after the beginning of June drop) to avoid excessive fruit thinning. NAA products (K-Salt Fruit Fix 200, K-Salt Fruit Fix 800, Fruitone, PoMaxa, Refine) may similarly be applied as a single application at 3–5 ppm five to six weeks after bloom to induce flowering the following year. If results are unsatisfactory after the first year, 1–2 applications may be required the next year at 7–10 day intervals to stimulate flowering. Biennial or alternate bearing can be problematic in a number of apple cultivars, particularly Golden Delicious, Honeycrisp, Cameo, and Fuji. In an "on" year, trees in biennial cycles set heavy crops which generally produce high numbers of small fruit, often with poor color and eating quality; in the "off" year, flowering and fruit set are typically very low, resulting in small yields of large fruit that can be prone to physiological disorders suchs as bitter pit. Effective pruning and chemical thinning are crucial to mitigating biennial bearing patterns, but strategic use of plant growth regulators may also help promote consistent annual cropping. Ethephon may be applied 5-6 weeks after bloom in the heavy crop year to improve flowering the next season. NAA may also be applied in single or multiple applications at 3–5 ppm starting five to six weeks after bloom to induce flowering the following year. Even though these spray programs may be popular in some sectors of the apple industry, growers should be advised that ethephon and NAA have rarely increased return bloom in several years of WA research trials. Caution: Applications of ethephon may reduce fruit size. Early-season applications of ethephon before the start of June drop may cause excessive thinning. Use of ethephon on weak trees can produce excessive thinning, excessive flowering the following season, and stunting of growth. | | | | |
| To reduce return bloom (to mitigate biennial bearing) | **Gibberellins A4A7**<br>Arrange | 25 - 200 ppm | 4 hours | none listed | To help suppress biennial bearing of apple, apply Arrange in the "off" or light-cropping year of the biennial cycle to reduce the amount of bloom in the subsequent growing season (the "on" or heavy-cropping year of the biennial cycle). Application of Arrange to trees with heavy crop loads may aggravate the severity of biennial bearing; hand gun applications to individual trees in blocks with significant tree-to-tree crop load variability may be advisable. Multiple applications of smaller doses of Arrange may be more efficacious than a single application at a higher rate. Trees in severe alternation may not respond as clearly as trees in moderate alternation. Consult the product label for more information. **Organic** |
| To suppress fruit russet | **Gibberellins A4A7**<br>Novagib 5L | 4.0 - 6.6 fl oz | 4 h | none listed | **Organic** |
| | **Gibberellins A4A7**<br>ProVide 10SG | 2.1-3.5 oz | 4 h | none listed | **Organic** |

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| Vegetative growth control in apple | **prohexadione calcium**<br>Apogee PGR | 6-24 oz | 12 h | 45 d | |
| | **prohexadione calcium**<br>Kudos 27.5 WDG | 6-20 oz | 12 h | 45 d | |
| | **Notes**: Prohexadione calcium (Apogee, Kudos 27.5WDG) is a potent inhibitor of gibberellin biosynthesis, resulting in reduced shoot growth and overall tree vigor. Applications should only be made to trees of moderate to high vigor. Treatment with prohexadione calcium may encourage formation of terminal shoot buds, causing an arrest of shoot elongation; if terminal buds do not form, those shoots may experience a second flush of growth later in the season which can be difficult to with subsequent applications unless coverage has been maintained throughout the season with repeat applications. Growth control from a single application of prohexadione calcium lasts only a short time (4 to 6 weeks maximum under most conditions). A minimum of two applications per season is advised under Washington conditions, but more may be needed to maintain season-long control over shoot growth. For best results, the first application should be made early, when newly-forming terminal shoots are no more than 1 inch in length. Subsequent applications should be made at intervals of 2-3 weeks. Good results have been obtained in Washington using a rate of 6-12 ounces per 100 gallons spray volume of water. Spraying dilute (i.e. 200 gallons per acre) tends to increase product efficacy. Growers should carefully follow the growth response to prohexadione calcium in their orchards and make adjustments in both rate and timing as necessary to improve the response. Three to five applications may be necessary for high vigor trees having a light crop load. Follow label directions for adjuvants and recommendations for mixing and applying prohexadione calcium. CAUTION: Do not mix prohexadione calcium with any spray products containing calcium or in water with naturally high calcium levels; the efficacy of the prohexadione calcium will likely be reduced. If “hard” water must be used, add one pound of high-quality, spray-grade ammonium sulfate for each pound of Apogee or Kudos 27.5WDG used, check spray water pH, and adjust to a pH value lower than 7 before spraying. | | | | |

## Apples non bearing

| Symptom/Behaviour | Chemical | Rate per Acre | REI | PHI | Notes |
|---|---|---|---|---|---|
| To promote lateral branching (1-3 in terminal growth) | **Gibberellins A4A7 + BA**<br>Perlan | 125 - 500 ppm | 4 h | none listed | |
| | **Gibberellins A4A7 + BA**<br>Promalin | 125-500 ppm | 4 h | none listed | 0.25-1 pt per 5 gal. Use with surfactant. |
| | **Notes**: Apply at 1 to 3 inches of new terminal growth. Approximately 5 to 10 gal of spray mixture applied with a pressurized hand sprayer will treat 200-300 nonbearing orchard trees 1 to 4 years old. Rate depends on tree vigor. Do not use on weak trees or stunted trees on M9 rootstocks. Do not apply after buds break. Applications after buds have broken may cause some injury to tender shoot tips and fail to promote shoot growth from that point. | | | | |
| To promote lateral branching (bud swell) | **Gibberellins A4A7 + BA**<br>Perlan | 5000 - 7500 ppm | 4 h | none listed | |
| | **Gibberellins A4A7 + BA**<br>Promalin | 5000-7500 ppm | 4 h | none listed | |
| | **Notes**: Apply in spring when terminal buds begin to swell but before green tissues emerge. Mix with latex paint. 0.2-0.33 pt per pt of paint. Apply the GA4+7+BA-latex mixture with a brush or sponge to thoroughly cover the bark surface where growth is desired. Apply only to 1-year old wood. | | | | |

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