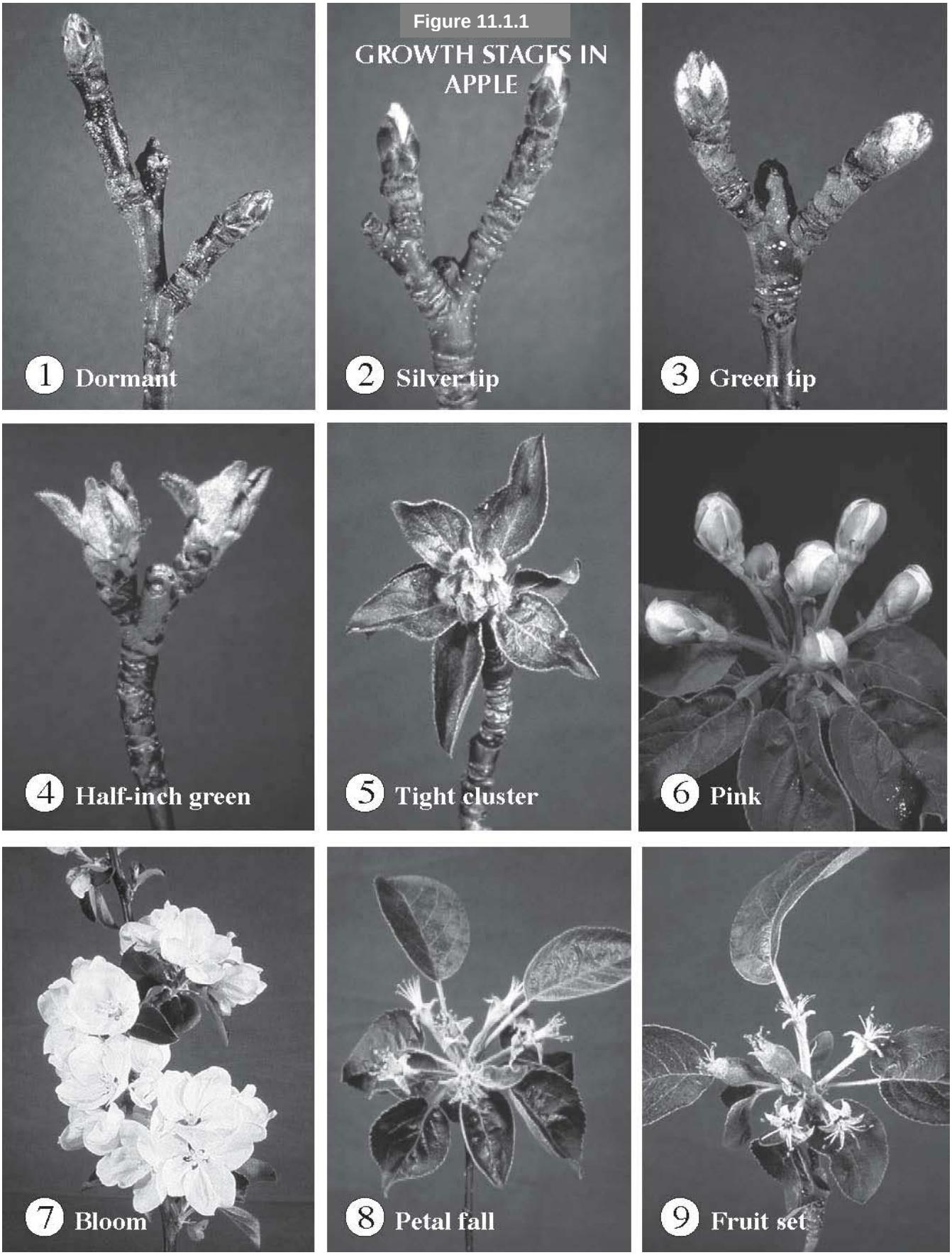
Figure 11.1.1


GROWTH STAGES IN APPLE
1 Dormant
2 Silver tip
3 Green tip
4 Half-inch green
5 Tight cluster
6 Pink
7 Bloom
8 Petal fall
9 Fruit set

11 General Pest Management Considerations – Apples

11.1 Diseases

Apple Scab

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[1.1] See discussion of inoculum reduction in the disease management section. Scab fungicide sprays beginning at green tip are absolutely essential in orchards with high carry-over inoculum or orchards where scab control with SI fungicides was less than satisfactory in previous years. If early season infections are allowed to become established, even the best fungicide programs will not prevent development of fruit scab in orchards where the scab fungus has developed resistance to all three of the fungicide groups (dodine, benzimidazoles, SI's) that previously provided presymptom and postinfection activity against apple scab.

[1.2] Fungicide rates per acre should never be reduced below either (i) 50% of the per-acre rate listed on the label or (ii) 1.5 multiplied by the rate/100 gal listed on the label. This applies even when spraying small trees. Although tree-row volume calculations may suggest that lower rates are appropriate, applying less than 50% of the per-acre rate has frequently resulted in unsatisfactory scab control and/or more rapid development of fungicide resistance.

In orchards with SI-resistant scab, a combination of a mancozeb fungicide at 3 lb/A plus a captan formulation that supplies 1.5 lb of active ingredient/A has provided excellent scab control when used in prebloom and bloom sprays. (A captan rate of 1.5 lb active ingredient/A translates to 3 lb/A of Captan 50W, 30 oz/A of 80W, or 1.5 qt/A for the 4L formulations.) This combination provides a better residual activity through heavy rains than would be available from either product used alone and it preserves the option of using mancozeb sprays after petal fall. The mancozeb-captan combination cannot be used close to prebloom oil sprays because of captan-oil incompatibilities.

For reasons of economy and resistance management, it is recommended that SI and strobilurin fungicides not be used until tight cluster, even when fungicidal protection is needed earlier; in such cases, make a single application of an alternative fungicide (captan, copper, EBDC) at green tip and half-inch green, then begin the SI/strobilurin program at tight cluster. Do not apply captan or sulfur within 10 days of an oil spray. Do not apply liquid captan formulations with sulfur on sulfur-sensitive varieties. A further discussion of apple scab fungicide characteristics is presented in the section "Apple Scab Fungicides" and in Table 6.1.2.

[1.3] Check fungicide compatibility with desired insecticide or oil; see [1.1].

[1.4] Sovran and Flint are excellent protectants, but they have only 48–72 hours of post-infection activity compared with 72–96 hr for the SI fungicides. Sovran and Flint also lack the presymptom activity that makes the SI fungicides so effective (in the absence of SI resistance) for arresting scab epidemics after primary scab lesions become visible in trees. Sovran and Flint have proven very effective against apple scab when applied at 7–9-day intervals to control primary scab, but they have not performed as well when used to control secondary scab in trees where scab lesions are already visible. Sovran and Flint control rust diseases fairly well when used as protectants, but they have little or no post-infection activity against rust diseases.

CAUTION: Sovran has caused moderate to severe phytotoxicity (leaf burning) on several sweet cherry varieties when sprayed directly onto them at high labeled rates. The *most sensitive varieties were: Somerset, Sweetheart, Valera, Van, and Vandalay;* these varieties might also be injured by spray drift containing Sovran. Minor to moderate injury occurred on Cavalier, Coral Champagne, Emperor Francis, Royalton, Schmidt, Summit, and Viva; there is less danger of injury due to spray drift on these varieties. Many other sweet and sour cherry varieties (including Bing, Brooks, Cashmere, Gold, Hardy Giant, Hartland, Hedelfingen, Hudson, Kristin, Lapins, Lambert, Montmorency, Napoleon, Nelson Black Sweet, Rainier, Royal Ann, Sam, Stark Crimson, Stella, Sue, Tehranivee, Tulare, Ulster, Vega, Vic, Viscount, and Windsor) showed no injury when sprayed directly with high labeled rates. The Sovran manufacturer recommends: (i) Do not apply Sovran near or allow drift onto cherries in the highly sensitive group (Somerset, etc.); and (ii) thoroughly rinse spray equipment (tanks, hoses, nozzles) after spraying Sovran and before using this equipment on sensitive cherry varieties.

[1.5] Although Rubigan, Procure and Nova have up to 96 hr of kickback activity, this activity depends strongly on rate. Do not use tree-row volume calculations with these products. They provide good curative activity when used at higher label rates (e.g., at least 10 fl oz/A of Rubigan or *Procure, or 6 oz/A of Nova) but are much less active at lower rates if applied more than 48 hr after infection. When applied beyond the effective kickback period, many infection sites are merely suppressed but not eradicated. In such cases, if a 2nd spray is applied 7–10 days later, most of these lesions will finally be killed or inactivated; however, if no additional material is applied, the suppressed lesions may eventually become active again.

IMPORTANT: Good spray coverage is especially critical for SI fungicides. Poor spray coverage not only provides poor control but speeds the selection of scab strains that are resistant to the SI fungicides. Experience has shown that inadequate control occurs more frequently when spray concentrations are greater than 6X than when concentrations are 6X or less. Inadequate control due to poor spray coverage is also relatively common in unpruned or very tall trees.

[1.6] Primary inoculum pressure is generally at a peak from pink through bloom—this is a critical time to maintain full coverage with proper fungicide rates.

[1.7] Serious losses from apple scab are usually the result of secondary spread to developing fruits. Therefore, it is important to carefully check blocks for the presence of primary scab lesions from petal fall through the early cover spray period. This is particularly important because fruit are most susceptible to infection during the first few weeks of their development. If scab is detected, the management strategy should be to (i) thoroughly protect the sensitive young fruitlets from fungal spores that are present, AND (ii) limit the number of new spores that can be produced. To protect fruitlets, use (a) the full rate of captan (e.g., 2 lb/100 gal of the 50WP formulation), or (b) the reduced rate of an EBDC fungicide (if allowable) supplemented with a half rate of captan, or (c) a strobilurin fungicide combined with a contact fungicide. To limit new spore production, use (a) an SI fungicide through 2nd cover (to prevent new leaf lesions), or (b) a registered strobilurin fungicide (to prevent new leaf lesions and suppress spore production from existing lesions), or (c) dodine (to "burn out" existing lesions). SI's and dodine should be used only in orchards where there is no resistance to these fungicides. (**CAUTION:** Applications of dodine after bloom may cause russeting on russet-sensitive varieties). With repeated use, all three of these options will speed the development of resistance. Thus, they should be viewed as emergency "rescue" operations, and increased care should be taken in future seasons to avoid the development of primary scab that necessitated their use.

[1.8] The EBDC fungicides (mancozeb, maneb, Polyram) are labeled for use on apples in one of two different ways: (i) at a rate of 1.5–2 lb/100 gal (maximum 6 lb/A, no more than 24 lb/A per year), not to be applied after bloom; OR (ii) at a reduced rate of 3 lb/A (maximum 21 lb/A per year), which may be applied to within 77 days of harvest. It is illegal to use the reduced rate (3 lb/A) after bloom if the rate for any of the sprays prior to petal fall exceeded 3 lb/A.

[1.9] The danger of primary scab is over after 1st cover except when drought conditions delay spore release. If primary scab has been well controlled, fungicide schedules and rates can be relaxed after the danger of primary infection is past. For best control of mildew, apply an SI or strobilurin fungicide through 2nd cover on bearing trees and through 4th cover on non-bearing trees.

[1.10] The use of Nova, Rubigan or Procure beyond 2nd cover is specifically NOT recommended, except in non-bearing orchards where they may be needed for mildew control during the summer. Spraying them during the summer increases the likelihood of selecting strains of the scab fungus that are tolerant of these compounds. Excessive use of Bayleton, Nova, *Procure, or Rubigan also increases the possibility of developing powdery mildew resistance to these sterol-inhibitor compounds.

• Pesticide Resistance

[1.11] Apple scab and powdery mildew resistance to Topsin M and Thiophanate-methyl is widespread, though it has not been confirmed in New England. Once resistance develops it will persist indefinitely. Thus, these products should NOT be relied upon for apple scab or mildew control in orchards or regions with a long history of use.

[1.12] Sensitivity to the SI fungicides (Nova, Procure, Rubigan) is declining among some populations of the apple scab and powdery mildew fungi. These materials still provide apple scab control in some orchards, but they are totally ineffective in other orchards. Declining efficacy usually appears in orchards with a history of regular SI use (3–5 applications for 10+ yr) under high disease pressure, whereas no decline is apparent in orchards where the materials have been used sparingly or in tight schedules with low levels of inoculum. In order to maintain the usefulness of these products, it is recommended that they be used: (a) at full rates with thorough spray coverage; (b) only in tank-mix combinations with another effective scab fungicide; and (c) no more than 2–3 times per season.

[1.13] Sovran and Flint are prone to resistance development, and resistance to one member of this class confers resistance to other products in the class (cross-resistance). The primary strategies for reducing this risk are to rotate the strobilurins with unrelated fungicides, to limit the number of seasonal applications of a strobilurin (e.g., 3-4 per year), and to tank mix strobilurins with full rates of captan when treating trees with visible scab lesions.

Apple Rust Diseases

• Biology & Cultural

[2.1] Varieties that are susceptible to cedar apple rust include: Arlet, Braeburn, Fuji, Gala, Ginger Gold, Goldrush, Golden Delicious, Idared, Jonathan, Lodi, Mutsu (Crispin), and Rome. All varieties are susceptible to quince rust under favorable weather conditions. See Table 6.2.3 for a precise listing of temperature and wetting periods necessary to cause cedar-apple rust infections. Maintain short intervals during periods of wet weather in orchards where quince rust fruit infections have been a problem. Quince rust infections are most likely to develop when long wetting periods (48 hours or more) occur between tight cluster and first cover and the average temperature is greater than 50° F.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest.

• Pesticide Application Notes

[2.2] Where apple rust diseases are a problem, sprays normally must be applied at 7- to 10-day intervals from pink until 2–3 wk after petal fall. Nova, Rubigan, Procure, and Bayleton have kickback activity against cedar apple rust. If an infection period should occur when foliage is poorly protected, it is recommended that one of these materials be applied within 3 days of the start of the infection period or as soon thereafter as weather conditions

permit. The strobilurin fungicides (Sovran, Flint) provide moderate protection against rust diseases when applied on a 7-day schedule, but they have little or no kickback activity.

[2.3] The lower rate and extended season use of the EBDC fungicides is adequate for control of rust diseases, and the extended timing is necessary to control rust infections on terminal leaves. It is illegal to combine or integrate the two treatment regimes.

[2.4] Where apple rusts are a problem, include a suitable rust fungicide in the first two cover sprays.

Bitter Rot

• Pesticide Application Notes

[3.1] Although the EBDC fungicides are effective against bitter rot, the 77-day PHI does not allow them to be used in late summer when most bitter rot infections occur. Captan and Pristine are the best materials available. Bitter rot has the potential for "explosive" development, thus captan rates should be increased to their upper labeled range (equivalent to 1.5–2 lb/100 gallons of the 50WP formulation) if the disease begins to develop and hot, wet weather is anticipated. Under such conditions, tight spray schedules should be maintained until 2 wk before harvest. The higher captan rates should be used even in combinations with Topsin M, since these fungicides have very little effect against bitter rot. Flint at 2.5 oz/A is also effective against bitter rot.

Black Rot, White Rot (frog-eye leaf spot and fruit infections)

• Biology & Cultural

[4.1] Black rot inoculum is retained within trees in dead wood (e.g., old fire blight strikes) and fruitlet mummies; therefore, it is important to remove these sources to whatever extent possible. The critical periods for controlling black rot fruit infections are (a) from the 1st through 3d cover sprays, when fruitlets killed by thinning sprays become infected (they become inoculum sources), and (b) during late summer, when maturing fruit are especially susceptible. Where black rot was not controlled well the previous year, protectant sprays may be needed at 2–3-week intervals until late August.

Black rot cankers cannot be controlled with fungicide sprays. Cankers develop primarily after wood has been weakened by other factors (e.g., drought, winter injury). However, the white rot fungus may establish superficial cankers on trees that receive only mancozeb and/or SI sprays during the primary scab period. Those superficial cankers can suddenly girdle limbs if trees become severely drought-stressed. Using a copper fungicide at green tip and/or including a fungicide with activity against black rot/white rot in the prebloom scab control program should help to control superficial white rot cankers.

• Pesticide Application Notes

[4.2] Many sprays aimed at scab and rust are also effective against the black rot fungus. Topsin M and Thiophanate-methyl are highly effective. Captan and the strobilurin fungicides (Sovran, Flint) provide good control. The SI fungicides (Bayleton, Nova, *Procure, Rubigan) do not control black rot. Polyram and mancozeb fungicides are effective at the maximum label rate but have little activity when used at the lower rates that are labeled as applications after petal fall. Ziram at 1.5–2 lb/100 gallons (dilute basis) is only moderately effective (OK when inoculum levels are low), but is often ineffective at 1lb/100 gallons (dilute basis) or less.

NOTE: The frog-eye leaf spot phase of black rot is sometimes misdiagnosed, because identical symptoms can be caused by (a) spray materials that are phytotoxic to leaves; or (b) cedar apple rust infections whose development is arrested by the application of an SI fungicide or by a host-resistance response such as occurs when the rust fungus begins attacking unsprayed McIntosh, Empire, or Liberty leaves. Mancozeb and Polyram are the best materials for protecting against rust-induced leaf spotting.

[4.3] Topsin-M, Thiophanate-methyl, Captan, and the strobilurins are the only fungicides that provide effective control of black rot during the critical periods if disease pressure is moderate to high. Ziram at 1.5–2 lb/100 gallons (dilute basis) is only moderately effective (OK when inoculum levels are low), but is often ineffective at 1lb/100 gallons (dilute basis) or less, as are mancozeb and Polyram at the reduced rates allowed after bloom.

Blister Spot

• Pesticide Application Notes

[5.1] This is an economic problem primarily on Crispin (Mutsu), but Fuji occasionally shows symptoms when planted near Crispin. Apply the 1st spray 10–14 days after petal fall. A delay in applying this spray will significantly reduce control in most years. Two additional sprays should be applied at weekly intervals if any rain occurs. Do not apply more than 3 sprays. The use of 2–4 lb Kocide or C-O-C-S/100 gal between green tip and 1/2-inch green in the spring may reduce overwintering inoculum and provide a small amount of additional control. Additionally, application of Aliette (or phosphorous acid or phosphite products) during pink, petal fall, and early cover sprays may also reduce infections.

• Pesticide Resistance

[5.2] Streptomycin-resistant blister spot bacteria are present in Crispin orchards in western New York. Streptomycin will continue to provide some control after resistance is first detected, but this degree of control will gradually diminish in succeeding years if strep is continuously used. Recent research indicates that resistance levels within an orchard diminish significantly after one season if no strep is applied. Thus, once resistance becomes pronounced, strep is likely to be most effective if used only

in alternate years. There are no alternative bactericides for use in apple orchards against blister spot.

Blossom End Rots

• Biology & Cultural

[6.1] Blossom end rot can be caused by *Botrytis cinerea, Sclerotinia sclerotiorum,* and *Botryosphaeria obtusa*. It occurs sporadically and is most likely to become a problem if the weather is warm and wet between bloom and 1st cover. McIntosh, Delicious, Rome, and Paulared are most commonly affected.

• Pesticide Application Notes

[6.2] Where blossom end rot has occurred before, use captan, Sovran, Flint, Topsin M or Thiophanate-methyl in the bloom, petal fall, and 1st cover sprays if the weather conditions are favorable for infection. Vangard and Scala will control infections caused by *Botrytis*, but they may be less effective against blossom end rots caused by *Sclerotinia* or *Botryosphaeria.*

Crown Rot (Collar Rot)

• Biology & Cultural

[7.1] Crown rot is primarily associated with trees on moderately to highly susceptible rootstocks (particularly MM.106 and young trees on M.26). It can also develop on moderately resistant rootstocks planted in poorly drained sites or in very wet years. Seedling and M.9 appear to be the least susceptible of the common rootstocks.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest.

• Pesticide Application Notes

[7.2] Ridomil should be considered in sections of the orchard where crown rot has been a problem, or where the combination of marginal drainage and rootstock susceptibility indicates a potential problem. Make a solution containing 8 fl oz Ridomil Gold 4EC/100 gal of water and apply this solution to the soil around the trunk at the following rate:

Trunk diameter (in.)	Solution (qt)
1	1
1–3	2
3–5	3
5	4

Apply just as growth begins in the spring and repeat immediately after harvest. Do not apply to newly planted trees. Ridomil is an effective protective fungicide, but is unlikely to cure trees in moderate to severe stages of decline.

[7.3] Apply 4 lb/A of Aliette 80WP as a foliar spray, or use one of the phosphorous acid or phosphite products labeled for this use. Make 1st application in spring after sufficient foliage is present to absorb chemical. Repeat every 60 days; maximum 4 applications/yr. Unlikely to cure trees in moderate to severe stages of decline.

Fire Blight

• Biology & Cultural

[8.1] Fire blight is a potentially damaging disease on highly susceptible varieties such as Crispin (Mutsu), Fuji, Gala, Gingergold, Honeycrisp, Idared, Jonathan, Lady Apple, Monroe, Paulared, R. I. Greening, and Wayne. Many other varieties can become diseased if conditions are particularly favorable for disease development. The potential for tree loss is especially high when susceptible varieties are grown on susceptible M.26 and M.9 rootstocks (or interstems), since blight can move into them from the scion or infected root suckers and kill the tree.

[8.2] Pruning out infected shoots to limit the spread of shoot blight is of doubtful benefit on large trees but is recommended on young or small trees, particularly those on M.9 or M.26 rootstocks or interstems. To effectively limit damage, strikes should be pruned out as soon as they appear throughout the terminal growth period; begin checking for symptoms about 90–100 degree days (base 55° F) after an expected infection event such as rain during bloom or a summer hailstorm. Should blight develop, it is also important to maintain control of pear psylla and potato leafhopper because these insects can contribute to shoot blight infections. Recent research indicates that aphids and white apple leaf hopper are less important in spread of fire blight.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest.

• Monitoring & Forecasting

[8.3] Serious fire blight problems are usually the result of infection during bloom. The need for streptomycin sprays during bloom depends upon a combination of both orchard risk factors and weather risk factors. If weather conditions favor blossom blight infections, streptomycin is strongly recommended for orchards where risk factors are high (highly susceptible scion and rootstock cultivars, active fire blight or past history of fire blight in the orchard or in neighboring orchards).

Streptomycin is effective in preventing blossom infections. However, precise timing is required because only those blossoms that are open at the time of the application are protected and there is no redistribution to new blossoms by rainfall. It is currently recommended that in orchards at moderate or high risk, streptomycin should be applied if weather has been relatively warm since full pink AND forecasts indicate the probability of rain or showers in the next 24 hr at temperatures greater than 60° F. A program to initiate spraying once 200 degree hours (base 65° F) have accumulated since full pink (first open blossom in the orchard) has proven effective in several locations and should serve as an approximate guideline. [Example: To calculate degree hours for a particular day, assume 6 hr at the high temperature, 6 hr at the low, and 12 hr at the

average of the two. Thus, for a day with a high of 80° F, a low of 60° F, and an average of 70° F, the number of accumulated degree hours can be calculated as: 6 hr x 15 degrees above 65 for the high + 6 hr x 0 degrees above 65 for the low + 12 hr x 5 degrees above 65 for the average, or 90 + 0 + 60 = 150 accumulated degree hours]. Thus, once 200 or more degree hours have accumulated, strep should be sprayed before the next forecasted rain, providing that temperatures are 60° F or higher. Fire blight forecast models MaryBlytTM and Cougar Blight are commonly used to predict fire blight risk in New England. Cougar Blight is available at the following web site http://www.ncw.wsu.edu/ treefruit/fireblight/2000f.htm.

The need for additional streptomycin treatments should be determined starting 3 days after an application, and streptomycin should then be reapplied to protect newly opened blossoms before the next rain occurs. Streptomycin also provides control if applied within 24 hr after a wetting event begins. Antibacterial activity depends upon absorption by the blossoms; therefore, streptomycin should not be applied immediately before or during a rain. Thorough coverage is essential for control. The application of streptomycin at concentrations greater than 6X has been associated with reduced levels of control and is, therefore, not recommended. Refer also to [8.5] and [8.7].

• Pesticide Application Notes

[8.4] Copper applied at green tip will not eliminate the need for streptomycin at bloom. However, it is effective in reducing the population of overwintering fire blight bacteria and is a useful component of an overall fire blight control program. Thorough coverage of the entire tree is necessary for maximum effectiveness, so dilute or high gallonage sprays are preferred. This is also an effective scab spray, but is likely to cause injury if applied beyond 1/4-inch to 1/2-inch green. The oil should be added at a rate of 1 qt per 100 gal of actual spray solution in the tank (i.e., do not concentrate the oil). Oil is added to increase efficiency of the copper, but will not control mites when applied at this time and rate. If using Bordeaux mix, prepare as described in the section "Fungicides." Add the oil after adding lime, but before making the mix up to final volume. Several other commercial copper formulations in addition to those listed are labeled for this use on apples. Although they have not been tested, research on other crops suggests that most copper formulations should give comparable rates of control at comparable rates of metallic copper.

[8.5] To reduce the chance of developing resistance, the routine use of streptomycin to control the spread of shoot infections is discouraged. However, an application of streptomycin is recommended following a hailstorm in fire blight-affected orchards, provided that such a spray can be applied without violating the preharvest interval. This application may be critical if even moderate amounts of blight were present before the storm. Sprays should be completed within 24 hr after the start of the hail.

[8.6] Apogee is a growth regulator that has given good control of fire blight infection of shoots, but is ineffective for control of blossom infections. Apogee should be applied in late bloom or early petal fall (when shoots are 1–3 inches long) at 6–12 oz/ 100 gal, with a second application 3-4 weeks later (Important: see recommendation and comments under "Growth Regulator Uses in Apples" section for more information about Apogee and water quality requirements). Because Apogee has no effect on preventing or slowing fire blight infections for at least 10 days after application, the need for application must be determined prior to the appearance of fire blight symptoms in the orchard. The need for application should be based upon the number of fire blight infection periods that occur during bloom and the severity of fire blight the previous season, as well as the susceptibility of the scion variety and rootstock. If Apogee is to be applied to trees less than 5 years old, the rate of application should be reduced to 3–6 oz/100 gal, and the grower must balance the benefit of shoot blight control against the drawback of reduced shoot growth. Apogee may affect thinning programs (see "Growth Regulator Uses in Apples").

[8.7] Serenade can be integrated into a fire blight control program, but it has been consistently less effective than streptomycin. Therefore, Serenade should be used only in a rotational program with streptomycin and not as the sole bactericide for fire blight management. Research suggests that streptomycin should be the first product applied during bloom, particularly when conditions are very favorable for the development of fire blight. Serenade should be applied 24 hr after the infection event.

Powdery Mildew

• Biology & Cultural

[9.1] Powdery mildew survives the winter in vegetative or fruit buds that were infected the previous season. Winter temperatures below –11° F can kill the mycelium in the buds and temperatures below -24° F can kill many of the infected buds, thereby reducing overwintering infections and inoculum potential for the next growing season. Baldwin, Cortland, Crispin, Gala, Ginger Gold, Honeycrisp, Idared, Jonathan, Monroe, Paulared, and Rome are highly susceptible varieties. Other less-susceptible varieties may also become seriously diseased in certain years, particularly if planted near trees where mildew is not well controlled. Rain is not necessary for infection to occur; therefore, mildew sprays must be maintained even during prolonged dry spells when scab sprays aren't necessary. Mildew develops slowly at temperatures below 50° F so mildew sprays are relatively unimportant until temperatures regularly exceed this level. Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest.

• Pesticide Application Notes

[9.2] Sulfur is effective against mildew, but it has short residual activity and must be reapplied every 7 days for good results. There is danger of phytotoxicity on some varieties, particularly at higher temperatures (80° F and above) or if applied with or near an oil spray. The SI

fungicides (Nova, Procure, Rubigan) are the most effective materials for control of powdery mildew. SI programs can usually start about 1 week later than sulfur programs and are effective at 10–14-day intervals. They have provided good commercial control when used from pink through 1st or 2nd cover. The strobilurin fungicides (Sovran, Flint) provide good control of powdery mildew, but have been slightly less effective than the SIs. Rotational programs involving SI's followed by strobilurins are as effective as previous SI-only programs and will help manage the development of resistance to both fungicide groups. Topsin M was an excellent powdery mildew fungicide, but it has provided poor control in many orchards in recent years.

[9.3] JMS Stylet Oil also provides mite control but has incompatibility problems with several other pesticides, including captan and sulfur. Refer to label for specific restrictions.

[9.4] Although triadimefon is labeled for use at rates below 1 oz/100 gal, rates below 1 oz/100 gal are ineffective against powdery mildew in many orchards because mildew is has developed resistance to lower rates of this fungicide.

[9.5] Do not delay mildew sprays beyond pink.

Sooty Blotch and Fly Speck

• Biology & Cultural

[10.1] Sooty blotch and fly speck develop gradually during periods of very high humidity; thus they are favored by frequent showers, prolonged cloudy weather, poor air circulation, dense tree canopies, and clustered fruit. These diseases are particularly damaging when rainy weather persists through summer and allows repeated cycles of secondary spread. Inoculum for sooty blotch and flyspeck often comes from alternate hosts in adjacent woods and hedgerows, such as trees, shrubs, vines, particularly wild brambles. Removal of these plants to whatever extent possible (e.g., bush-hogging fencerows or ditchbanks) will aid in disease control. Summer pruning, which increases air movement through the tree canopy, also aids in control of these diseases. After spores land on unprotected fruit, 270 hr of accumulated wetting are required before flyspeck will become evident on fruit.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest.

• Pesticide Application Notes

[10.2] Ascospores of the flyspeck fungus can be blown into orchards beginning near petal fall, but fungicides applied for scab control are usually adequate to control these early season infections. The real risk of flyspeck infection escalates when secondary spores become available in woodlots and hedgerows. This occurs after approximately 270 hours of accumulated wetting (rains and dew periods) counting from petal fall. Topsin M, Sovran, Flint, and Pristine all arrest development of flyspeck infections on fruit if they are applied after infections have occurred, but the infections resume growing after fungicide residues are depleted. Applications of Topsin M, Sovran, Flint, or Pristine should then be renewed at 14–21 day intervals. If all fungicide coverage is removed by heavy rains (> 3 inches after the last spray) during late August or early September, a late-season spray may be needed to control disease on cultivars that will not be harvested within 25–30 days after fungicide coverage is depleted. Effectiveness of late-season sprays is largely dependent on spray coverage within the tree.

[10.3] Captan is relatively weak against sooty blotch and very weak against flyspeck; if using Captan for control of summer rot diseases, tank-mix with Topsin M, Flint or Sovran if sooty blotch and fly speck control are needed.

[10.4] For the best residual control of all summer diseases during the 30–50-day interval between the last spray and harvest, use either Pristine or Captan plus Topsin M in the last spray.

[10.5] Repeated tests in the Hudson Valley have shown that Ziram plus sulfur provides better control of these diseases than Ziram alone.

11.2 Insects and Mites

American Plum Borer refer to *Dogwood Borer*

Apple Aphid, Spirea Aphid

• Pesticide Application Notes

[11.1] *Vydate applied in the summer against leafminer will also control apple aphid. *Danitol will also provide suppression of European red mite. Do not make more than one application of Actara per season. Suggested action threshold: 30–40% of all terminals infested, OR 50% or more of the terminals with at least 1 aphid and less than 20% of the aphid-infested terminals with predators, OR 10% of fruit with honeydew or aphids. Natural enemies usually eliminate the need for chemical controls in New England.

Apple Maggot

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet and Sampling Guide containing details on the biology and management of this pest.

• Pesticide Application Notes

[12.1] 2–4 sprays at 14-day intervals beginning late June to early July, except: use 7-day intervals for Sevin and *Lannate. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. *Asana, *Battalion, *Decis, Delegate, *Proaxis, *Warrior or , Delegate, or SpinTor applied against other pests during this period will also control apple maggot. *Danitol will also provide suppression of European red mite. Suggested action

threshold: capture of an average of 1-2 apple maggot fliesy per red sphere trap hung in block, or an average of 5 flies per red sphere trap baited with apple volatiles. Refer to Fig. 8 and IPM Pub. No. 207 (*Apple IPM: A guide for sampling and managing major apple pests in New York State*) for details on trap monitoring.

[12.2] Frequent applications (7–10-day intervals) of Surround and maximal coverage (no less than one third of tree row volume dilute spray volume per acre) are advised in New England while there is active foliar growth.

Apple Rust Mite

• Biology & Cultural

[13.1] Occurs from late June to harvest, particularly on varieties with pubescent leaves; does not generally coincide with high red mite populations. Injury is a yellowish browning of leaves or white blotches on upper leaf surfaces.

• Pesticide Application Notes

[13.2] Only 1 application per season allowed on apple Suggested action threshold: 150–200 mites/leaf.

Codling Moth, Lesser Appleworm, And Oriental Fruit Moth

• Biology & Cultural

Refer to the reference materials list at the end of this publication for Fact Sheets containing details on the biology and management of codling moth and oriental fruit moth. Oriental Fruit Moth is not likely to be found in northern VT, NH or ME.

• Monitoring & Forecasting

[14.1] For orchards not receiving insecticide applications for plum curculio and apple maggot, or where codling moth is otherwise a significant problem, a Michigan field model can be used to estimate the optimum time to begin insecticide treatments. For larvicides (e.g. Assail, Calypso, Imidan, Guthion, Avaunt, SpinTor, Delegate) the optimum timing is at the beginning of codling moth egg hatch, which occurs at 250 degree-days (base 50° F) after 1st sustained adult catch for the 1st generation, and 1260–1370 DD after this same biofix date for the 2nd generation. However, when using insect growth regulators (IGR) Intrepid or Rimon the optimum timing is earlier. For Intrepid, recommended first application timing for codling moth is 100-200 degree-days after biofix. For Rimon, the recommended first application timing for codling moth is 50-100 degree-days after biofix for first generation, and at 1000 degree days for second generation.

• Biological & Non-chemical Control

[14.2] Where pheromone disruption of codling moth is used, dispensers should be applied before initiation of the 1st flight, which usually begins around petal fall. Isomate-C TT releases pheromone for 120-140 days.

Where pheromone disruption of oriental fruit moth is used, dispensers should be applied before initiation of the 2nd flight (late June to mid-July depending on location in New England); the need for re-application depends on residual field life of specific formulations: Isomate-M 100, 90 days; Checkmate and 3M Sprayable, 14 days. The residual life of the 3M sprayable deposit can be extended by the addition of a spreader-sticker such as Nu-Film-17 at 1 pt/A.

For both codling moth and oriental fruit moth, border insecticide sprays, or to the outer five rows, of pheromone disruptionorchards may be needed if there are unmanaged host trees or other sources of mated adult moths within 300 meters of or in other high pressure situations.

• Pesticide Application Notes

[14.3] Insecticide applied at petal fall and first cover against plum curculio contribute to control of codling moth, lesser appleworm and oriental fruit moth. In many orchards this incidental control displaces the need for insecticide applications targeted specifically for these pests.

*Asana, *Battalion, *Decis, *Proaxis, *Warrior or applied during this period will also provide control of codling moth, lesser appleworm, and oriental fruit moth, as will the insecticides listed for r apple maggot. Do not use within 30 days of full bloom unless fruit thinning is desired. *Guthion, Dimethoate and Biobit labeled only for codling moth. *Calypso, Dipel, *Imidan and Lorsban not registered for lesser appleworm. *Lannate not registered for oriental fruit moth.; Avaunt or Calypso, and to a lesser extent Assail, applied in first or second cover spray will control plum curculio. §Carpovirusine and §Cyd-X labeled for use against codling moth only. Use of a non-ionic surfactant is recommended with Assail.

[14.4] Summer sprays against oriental fruit moth should be timed to start approximately at the 10% hatch point, 175-200 DD (base 45° F) after the first adult catch of the second brood. Typical dates for optimum first application range from the 1st to the 3rd week of July in southern and northern New England, respectively. Best timing for a second application is 10-14 days after the first. In high pressure blocks, a final spray should be applied two weekswk before harvest to control late season larvae. Use of a non-ionic surfactant is recommended with Assail. Suggested action threshold: Avg. of >15 adults/week caught per pheromone trap.

Comstock Mealybug

• Biology & Cultural

[15.1] This pest problem is apparently encouraged by excessive use of synthetic pyrethroids (more than 2 applications/season).

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest.

• Pesticide Application Notes

[15.2] One spray advised against newly emerged crawlers, usually in late May (petal fall period). In severe cases, sprays against the 2nd generation may also be elected.

[15.3] Spray when crawlers 1st appear in summer, usually early Aug., and a 2nd spray 7–10 days later. Actara applied against other pests at this time will provide control of Comstock mealybug. Do not make more than one application of Actara per season.

Cutworms

• Biology & Cultural

[16.1] Cutworm problems are uncommon in apples in New England. Control of broadleaf weeds under trees is important.

• Pesticide Application Notes

[16.2] Apply spray when migrating larvae, or shoot or fruit injury, are first observed, usually in August. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties.

Dogwood Borer, American Plum Borer

• Biology & Cultural

Refer to the reference materials list at the end of this publication for Fact Sheets containing details on the biology and management of these pests. American plum borer can be a problem particularly in orchards adjacent to stone fruit plantings.

• Pesticide Application Notes

[17.1] One coarse spray of Lorsban to trunk burr knots between half-inch green and petal fall. If fresh borer activity is noted in early July, follow up with one additional spray of Lorsban (July 1–5) or two of *Thionex to burr knots (July 1–5 and August 1–5). PHI's = 28 days.

European Apple Sawfly

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[18.1] Particularly a problem in Southeastern New England; 1 spray at petal fall. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. Suggested action threshold: Cumulative capture of 3 adults/trap by 90% petal fall if no insecticide was applied at pink, or of 6 adults if an insecticide was applied at pink (white sticky-board trap).

[18.2] Actara, Avaunt, *Calypso and Lorsban will also control plum curculio when applied at this time. Do not make more than one application of Actara per season.

European Corn Borer

• Biology & Cultural

[19.1] Control of broadleaf weeds under trees is important.

• Pesticide Application Notes

[19.2] 1st generation spray: when migrating larvae, or shoot or fruit injury are first observed, usually in mid-June; 2nd generation: when larvae or injury to shoots or fruit is observed, usually in August. Be sure to note PHI limitations. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. SpinTor applied against late season leafrollers will also provide corn borer control (PHI = 7 days).

European Red Mite

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet and other resources containing details on the biology and management of this pest.

• Biological & Non-chemical Control

[20.1] The predaceous mite, *Typhlodromus pyri*, which is native to some apple production regions in New England, can successfully control populations of European red mite in commercial apple orchards so that no applications of miticides are required for seasonal control when selective pesticide programs are followed. This species also has been successfully introduced to some New England orchards. Refer to Tables 6.1.1 and 7.1 for ratings of pesticide effects on predatory mites, and to IPM Pub. No. 215 (*Achieving Biological Control of European Red Mite in Northeast Apples: An Implementation Guide for Growers*) for guidelines to implementing this approach.

• Pesticide Application Notes

[20.2] Oil is recommended at the 2–3 gal rate during the dormant period. This spray will also control European fruit scale.

[20.3] Good coverage is essential. Phytotoxicity from oil is more likely if sprays are concentrated more than 3X.

[20.4] Use 2 gal rate until tight cluster; reduce to 1 gal from tight cluster to pink. Good coverage is essential (300 gal/A recommended). San Jose scale, lecanium scale, and red bug are also controlled. See the "Acaricides" section of Fruit Crop Protectants for information on mixing and compatibility with fungicides. Suggested action threshold: 10% of spurs with eggs.

[20.5] One spray of Zeal, Apollo,Savey, or Envidor as soon as mite population exceeds threshold and within the first few weeks after petal fall before 1st generation mites lay their full capacity for 2nd generation eggs in enough water to obtain adequate coverage can provide season long control. The rate of formulated Apollo in finished spray solution should be 4–8 oz per acre. Envidor and Zeal are limited to 1 application per season.

[20.6] One application of oil up to pink if not previously applied at 1/2-inch green. Tank mixing Apollo or Savey with oil at tight cluster can extend period of residual efficacy in the summer. Suggested action threshold: 10% of spurs with eggs.

[20.7] Pink spray suggested only if oil, Zeal, Envidor, Savey or Apollo was not used earlier. *Vydate may provide some mite suppression; effective also on leafminer larvae and rosy apple aphid. Complete coverage of all leaf surfaces is required for best results. Envidor and Zeal limited to 1 application per season. Suggested action threshold: 2.5 nymphs/leaf.

[20.8] *Agri-Mek can be used anytime from petal fall to about 4 weeks afterward, but is most effective when applied before foliage begins to harden off, generally within the first 2 weeks after petal fall. Should be applied in combination with a horticultural spray oil (not a dormant oil) or other penetrating surfactant.

[20.9] Treatment with other materials generally not recommended at petal fall unless all previous sprays were either omitted or completely ineffective. Control failures with Kelthane have been reported from some New England orchards. Acramite, Envidor, Zeal and Nexter limited to 1 application per season; Kelthane, Kanemite and Portal limited to a maximum of 2 applications per season. *Vydate is a mite suppressant requiring back-to-back applications for control. Suggested action threshold: 1 mite/leaf or 30% of leaves with one or more mites. See Tables 6.1.1 and 7.1 for information about effects of pesticides on predatory mites.

[20.10] In orchards under an effective prebloom mite control program, a summer oil can effectively suppress mite populations when applied at petal fall and in 2 subsequent cover sprays at rates of 1qt–2 gal/100 gal finish spray solution, using a minimum of 100 gallons of spray per acre. Some leaf spotting may occur at the 2-gal/100 rate. The lowest rates in these 3 applications may not be adequate for season-long control under conditions of severe population pressure; however, effective control has been achieved in such conditions using 1/2 –1 gal/100 in a seasonal program starting at petal fall and continuing on a 2-week schedule until mid-August. Use of oil at concentrate rates increases the likelihood of phytotoxicity and is therefore not recommended. Do not exceed 1 1/2 gal per acre of PureSpray Green per application. Apple variety and spray drying conditions should be taken into account to minimize any possible effects on fruit finish.

[20.11] If oil is not to be used during the summer, 1 application of Acramite, Apollo, Envidor, Kanemite, Kelthane, Nexter, Savey, Zeal or *Vendex at 1st to 2nd cover, as needed. Apollo and Savey are primarily ovicides that will not directly reduce motile mite numbers. Use 8.8-10.7 oz of Nexter only for twospotted spider mite. For Kelthane and *Vendex, a 2nd application may be elected 10–14 days later (or, for Kanemite, 21 days later), as needed. Suggested action threshold: refer to Figs. 4–6 and IPM Pub. No. 207 (*Apple IPM: A guide for sampling and managing major apple pests in New York State*) for appropriate (date-dependent) threshold and sampling procedure.

Green Fruitworms

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[21.1] Growers can usually wait until petal fall to assess the need for this treatment. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. It is recommended that pyrethroids not be used more than 1–2 times/season in any orchard. Suggested action threshold: 3 larvae/tree on standard-size tree (27–40 trees/A); 1 larva/tree at density of 140 trees/A (semi-dwarf planting), lower for more closely spaced plantings.

Mullein Plant Bug

• Biology & Cultural

[22.1] Although predaceous on aphids and mites, nymphs occasionally damage fruit by feeding on flowers or young fruitlets. Damage appears as raised corky lesions and, in severe cases, fruit deformities. Most problematic in Red and Golden Delicious, Northern Spy, Empire and Spartan varieties.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest.

• Monitoring & Forecasting

[22.2] During bloom, tap 2 yr-old flower-bearing shoots over a black beating tray, especially in problem spots and those in proximity to areas containing mullein and evening primrose. Suggested action threshold: 10 nymphs per 40 limbs (4 on each of 10 trees). High populations can also be predicted from pheromone trap catches the preceding fall (more than 6/trap/day any time after Sept. 1).

• Pesticide Application Notes

[22.3] Susceptible to most insecticides applied at petal fall, but much damage has usually occurred by then. Broad spectrum pyrethroid insecticides (such as *Asana, *Battalion, *Decis, *Proaxis, *Warrior) or Lorsban applied at pink against other pests will provide incidental control, Mullein plant bug is not specifically listed as target pest on label for all of these products.Actara will also control spotted tentiform leafminer, rosy apple aphid and tarnished plant bug when applied at this time. Do not make more than one application of Actara per season. Assail and *Calypso will also control rosy apple aphid, spotted tentiform leafminer, 1st generation oriental fruit moth, and will suppress San Jose scale.

[22.4] Do not apply Assail when bees are actively visiting the area to be sprayed.

Obliquebanded Leafroller

• Biology & Cultural

OBLR is not a significant pest in most of New England. Refer to the reference materials list at the end of this publication for a Fact Sheet and Sampling Guide containing details on the biology and management of this pest.

• Pesticide Application Notes

[23.1] Bt materials are most effective against smaller larvae.

[23.2] Spray at petal fall to control overwintered larvae. Do not use Lannate on Early McIntosh, Dutchess, or Wealthy varieties. Lorsban will also control plum curculio. *Lannate will also control white apple leafhopper. *Danitol will also provide suppression of European red mite. Addition of a penetrating surfactant will improve efficacy of *Proclaim and SpinTor; application at petal fall will also control spotted tentiform leafminer. *Proclaim use limited to 4.8 oz/A of formulated product per season. Suggested action threshold: 3% infested tips (clusters and terminals); refer to Fig. 2 and IPM Pub. No. 207 (*Apple IPM: A guide for sampling and managing major apple pests in New York State*) for sampling procedure.

[23.3] For Bt products, greater efficacy against summer brood larvae has been shown with 2–4 sprays at the low rate on a 7-day interval, starting 10–12 days after first adult catch. For remaining products, 2–3 sprays, 10–14 days apart, against larvae, starting 360 DD (base 43° F) after 1st adult trap catch. Addition of a penetrating surfactant will improve efficacy of *Proclaim and SpinTor; SpinTor use limited to 3 applications per season. *Proclaim use limited to 4.8 oz/A of formulated product per season. It is recommended that pyrethroids not be applied more than 1–2 times/ season in any orchard. Use high rate of *Asana in problem orchards. Suggested action threshold: 3% infested terminals, refer to Fig. 2, and IPM Pub. No. 207 (*Apple IPM: A guide for sampling and managing major apple pests in New York State*) for sampling procedure.

Oystershell Scale

• Pesticide Application Notes

[24.1] Apply sprays at petal fall and 1st cover. Be aware of Sevin's fruit-thinning effects.

Plum Curculio

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Monitoring & Forecasting

[25.1] Because the length of plum curculio's immigration and oviposition period is affected by weather patterns after petal fall, spray coverage should be maintained until 308 DD (base 50° F) from petal fall.

• Pesticide Application Notes

[25.2] Petal fall and 1st cover sprays in northern New England; petal fall, 1st and 2nd cover sprays in southern New England.

[25.3] Frequent applications (7–10-day intervals) of Surround and maximal coverage (minimum of 100 gal/A) are advised in New York while there is active foliar growth.

[25.4] Actara, Avaunt, *Calypso and Lorsban will also control European apple sawfly when applied at this time. Do not make more than one application of Actara per season.

Redbanded Leafroller

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[26.1] Sprays effective against adults during 1/2-inch green and larvae at petal fall and 1st cover.

[26.2] Control is obtained from sprays applied at petal fall and 1st cover. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. Suggested action threshold: 2–3 larvae/tree.

[26.3] 3 applications advised starting in early June and at 12- to 14-day intervals to control second brood in problem areas. Suggested action threshold: 2–3 larvae/tree.

Rosy Apple Aphid

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet and Sampling Guide containing details on the biology and management of this pest.

• Monitoring & Forecasting

[27.1] Examine fruit clusters at the pink stage for the presence of wingless adults and nymphs. Refer to IPM Pub. No. 207 (*Apple IPM: A guide for sampling and managing major apple pests in New York State*) for sampling procedure. Suggested action threshold: one infested cluster. Cortland is the variety most commonly affected in New England.

• Pesticide Application Notes

[27.2] One spray of Lorsban, even if mixing with oil, or of *Supracide, from green tip to tight cluster. Research indicates greater effectiveness if control applied at pink. Suggested action threshold: 1 colony/100 fruit clusters.

[27.3] Good coverage is required for adequate control. Research indicates better effectiveness of all materials when used at pink. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. *Vydate and *Danitol may give some mite suppression when applied now. Do not exceed 4 pt *Vydate per acre. *Diazinon may

cause slight russeting on Golden Delicious. Actara will also control spotted tentiform leafminer, mullein plant bug and tarnished plant bug when applied at this time. Do not make more than one application per season. Assail will also control mullein plant bug, spotted tentiform leafminer, 1st generation oriental fruit moth, and will suppress San Jose scale. Pyrethroids will also provide effective control, but because of their toxicity to predatory mites, they are not recommended unless treatment is also required to control spotted tentiform leafminer and tarnished plant bug at this time. Suggested action threshold: 1 colony/100 clusters.

[27.4] This insect is difficult to control after pink; most damage has already occurred by this time. *Diazinon may cause slight russeting on Golden Delicious. *Calypso and Lorsban will also control plum curculio.

San Jose Scale

• Biology & Cultural

[28.1] Pruning to open up canopy is advised.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest.

• Monitoring & Forecasting

[28.2] 1st generation crawler emergence starts about 3 wk after petal fall (500 DD base 50° F from March 1, or 310 DD after 1st male catch); 2nd in late July-August (1451 DD from March 1, or 400 DD after 1st male catch of the 2nd generation).

• Pesticide Application Notes

[28.3] Prebloom sprays more effective if applied dilute, at high volume; follow up with summer applications. Suggested action threshold: 3–6 encrusted areas/tree.

[28.4] 2 sprays against first and peak (7–10 days later) crawler activity in both generations. Suggested action threshold: 1–2 crawlers/trap (sticky tape around limb).

Spotted Tentiform Leafminer, Apple Blotch Leafminer

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet and Sampling Guide containing details on the biology and management of this pest.

• Pesticide Application Notes

[29.1] A pyrethroid will also control rosy apple aphid and tarnished plant bug at pink. Do not exceed 14.5 oz of *Asana per acre per treatment; *Asana and *Danitol not registered for apple blotch leafminer. Actara and Avaunt will also control mullein plant bug and tarnished plant bug, and Actara will control rosy apple aphid, when applied at this time. Do not make more than one application of Actara per season. Suggested action threshold: 2 or more eggs/fruit cluster leaf; refer to Fig. 1 and IPM Pub. No. 207 (*Apple IPM: A guide for sampling and managing major apple pests in New York State*) for sampling procedure.

[29.2] Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. All materials at petal fall will also control white apple leafhopper; *Danitol and Lannate 90SP not labeled for apple blotch leafminer. Actara, Avaunt and *Calypso will also control plum curculio and European apple sawfly when applied at this time. Do not make more than one application of Actara per season. Suggested action threshold: against sap-feeding larvae, if mines exceed 1/leaf, or if eggs exceeded 2/leaf at pink. (Refer to Fig. 3 and IPM Pub. No. 207 [*Apple IPM: A guide for sampling and managing major apple pests in New York State*] for sampling procedure.)

[29.3] For 2nd brood: Do not apply *Vydate within 30 days of bloom. Do not use *Lannate on Early McIntosh, Dutchess or Wealthy varieties. Suggested action threshold: if 2nd brood sap-feeding mines exceed 2/leaf on mature terminal leaves. Before first tissue-feeding mines appear, examine 10 mature terminal leaves from each of 5 trees. (Refer to Fig. 7 and IPM Pub. No. 207 [*Apple IPM: A guide for sampling and managing major apple pests in New York State*] for sampling procedure).

[29.4] Abba .15EC must be mixed with horticultural oil to be effective. Preferred timing is when eggs or early sap feeders are present. It must not be applied during bloom

[29.5] Esteem 0.86E Minimum 50 gallons per acre. Thorough coverage is critical for good control. Proper timing for first generation is just before or during pink stage.

[29.6] SpinTor must be mixed with an approved adjuvant to be effective. Optimal timing is when miners are in sap-feeding stage

Tarnished Plant Bug

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[30.1] One spray advised at tight cluster to petal fall if an unusually high prebloom population is present. A pyrethroid at pink will also control spotted tentiform leafminer and rosy apple aphid. It is recommended that pyrethroids not be used more than 1–2 times/season in any orchard. Actara and Avaunt will also control mullein plant bug and spotted tentiform leafminer, and Actara will control rosy apple aphid, when applied at pink. Do not make more than one application of Actara per season. Suggested action threshold: 2–3 bleeding sites/10-terminal sample.

[30.2] Battalion maximum 26.9 fl. oz/A per season, and 7 days between applications

[30.3] Decis 1.5EC: maximum 3.6 fl oz/A per season. Allow 7 days between applications.

[30.4] Lambda T: maximum of 1.6 pts/aacre per year

[30.5] Thionex 50W: max. 2 applications during fruiting period

[30.6] Tombstone 2 EC: Minimum 100 GPA for ground equipment. Maximum of 2.8 fl oz/A per season

[30.7] Becautious about using Vydate soon after bloom. Fruit thinning can result

Variegated Leafroller, Sparganothis Fruitworm

• Pesticide Application Notes

[31.1] Occasionally a problem in the Hudson Valley, NY; in July if needed. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. Bt products not registered for Sparganothis fruitworm. Suggested action threshold: 3 larvae/tree on standard-size tree (27–40 trees/A); 1 larva/tree at density of 140 trees/A (semi-dwarf planting), lower for more closely-spaced plantings.

White Apple Leafhopper, Potato Leafhopper

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest. White apple leafhopper overwinters in New England, but potato leafhopper cannot. It typically appears in June.

• Pesticide Application Notes

[32.1] At petal fall or as nymphs appear later in summer. Will also control rose leafhopper. Do not use Sevin or *Vydate before 2nd cover unless fruit thinning is desired. Sevin not labeled for potato leafhopper. Do not apply more than 2 applications of *Thionex during fruiting period. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. Actara, Avaunt and *Calypso will also control plum curculio and European apple sawfly when applied at petal fall. Do not make more than one application of Actara per season. Suggested action threshold: average of 1 nymph/leaf.

[32.2] For potato leafhopper nymphs, 2–3 applications at the 0.5 oz rate are more effective than a single application at 2.0 oz.

Woolly Apple Aphid

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest. Woolly apple aphid is frequently held in check by a tiny parasitic wasp. Pesticide sprays can deplete the parasite population and trigger problems.

• Pesticide Application Notes

[33.1] In July when small colonies appear on periphery of canopy. Repeat applications may be necessary. Use of a non-ionic surfactant is recommended with Assail. Do not repeat* Diazinon applications closer than 14 days. Slight russeting may occur on some varieties, such as Golden Delicious. Suggested action threshold: as nymphs migrate to terminals.

11.3 Storage Disorders

Storage Rots

• Pesticide Application Notes

[34.1] Postharvest drench treatment of apples for control of storage rots is not recommend except when fruit must also be treated with diphenylamine (DPA) or calcium chloride. Holding tanks in postharvest drenching equipment must have good agitation to keep fungicides in suspension, and solutions must be replenished regularly as directed on the product labels.

Mertect 340F (thiabendazole) is no longer effective in many storages because strains of *Penicillium expansum* have developed resistance to the thiabendazole-plus-DPA combination. Storage operators who have noted decay problems in recent years should either switch to Penbotec or Scholar for their postharvest treatments, or they should use a mixture of Mertect 340F plus the full label rate of captan.

Penbotec and Scholar are new fungicides with modes of action that are different from each other and from that of Mertect 340F. Both of these fungicides are very effective against both blue mold (*P. expansum*) and gray mold (*B. cinerea*). Both are compatible with DPA and calcium chloride. Both are recommended for use as the sole fungicide in postharvest drenches (i.e., they do not need to be combined with captan).

To slow selection of pathogens with resistance to Penbotec and Scholar, it is recommended that storage operators alternate use of these products from one year to the next. Much of the inoculum for *P. expansum* recycles from one year to the next on apple bins. By using Penbotec in one season and Scholar the next (or Scholar the first year and Penbotec the next year), spore populations on bins will not be subjected to selection pressure by the same fungicide in successive years.

Some countries that import apples from the US may not accept fruit treated with Penbotec, Scholar, or Captan. For the latest information on maximum residue levels (MRL's) that have been established in various countries, check the following website: http://mrldatabase.com .

None of the postharvest treatments will control pinpoint scab, latent bitter rot or black rot infections that are present at harvest, or postharvest decays caused by *Alternaria*.

Chlorinated water can also be used to disinfect fruit after harvest. Numerous commercial formulations of calcium hypochlorite and sodium hypochlorite are available

with postharvest labels. However, chlorine only kills spores in the treatment solution and on the fruit surface at the time of treatment. It does not provide any residual protection. *Chlorine is **not** compatible with diphenylamine.* Thus, chlorination is most useful for disinfesting flume water on apple packing lines rather than as postharvest treatment prior to storage. Follow directions on the product label for maintaining appropriate levels of chlorine in treatment solutions.

Storage Scald

• Pesticide Application Notes

[35.1] Active ingredient may vary according to manufacturer: use label instructions to check rate required to obtain desired concentration. See Table 11.4.1 for varietal requirements.

Senescent Breakdown (Mcintosh)

• Pesticide Application Notes

[36.1] The addition of calcium chloride to the postharvest scald and storage rot treatment is effective in reducing McIntosh breakdown. Only calcium chloride that meets Food Chemical Codex specifications can be used in postharvest treatment of apples. Calcium treatment will be of little benefit to apples harvested after the projected optimum harvest date. Fruit injury from calcium chloride has been found to be associated with iron in the solution. Coat steel tanks or use plastic tanks and piping to minimize this problem.

11.4 Notes On Scald Control

11.4.1 Materials

All DPA (diphenylamine) formulations are suspensions and become weaker with use. Replenishment with full-strength material does not replace the DPA removed by the apples. Test kits are available to determine concentrations of make-up material. Do not exceed 30 bins or 750 bushels/100 gal of made-up DPA; empty the reservoir tank and start again with fresh material.

Cartons containing apples that have been treated postharvest with DPA and fungicide must be so labeled.

11.4.2 Application Equipment

Bins of apples are sometimes dipped into a tank containing postharvest preservatives, but more often the bins are moved by conveyors, rollers, or truck bed under a cascade of the preservatives. The bins should be moved slowly under the cascade, with 35-40 gal of preservatives being delivered into each bin. The pump should be sized to deliver 35-40 gal of preservatives/bin at the desired rate of bin movement under the cascade. If stacked bins are moved under the cascade, the top bins should receive 35-40 gal and side nozzles should be positioned to deliver additional gallonage to the lower bins, even though drainage holes are provided in the bin floors. Application equipment is commercially available, but operators usually fabricate their applicators to meet the needs of their own operation. Dirty truckloads should be rinsed with clean water before treatment to minimize the accumulation of dirt in the reservoir tank.

11.4.3 Variety Requirements

Materials and concentrations for the major apple varieties in New England are listed in Table 10.3.1. Important: DPA retards chlorophyll loss in Golden Delicious and, therefore, should not be used unless the apples have developed full yellow color at harvest.

The very low susceptibility of Empire to scald indicates that it can be safely stored without any preservative treatment. However, if preservative treatment is demanded, then use 1000 ppm DPA in the drench solution.

Table 11.4.1. Recommended diphenylamine concentrations for varieties subject to scald.

Variety	Diphenylamine (ppm)
Baldwin	1000-1500
Braeburn	1000
Cortland	2000
Delicious	1000-1500
Empire	1000
Golden Delicious	1000
Idared	1000
Jonagold	1000
McIntosh	1000
Mutsu	2000
Rome	1500
Stayman	1500

11.5 Apple Spray Table

Table 11.5.1. Pesticide Spray Table – Apples.

(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Silver Tip						
Apple scab inoculum reduction		Urea fertilizer ground spray	40 lb/A	0	0	[2.1]
Crown rot (collar rot)		Ridomil Gold 4EC	see comments	12	see comments	[7.2]
	OR	Aliette 80WP	see comments	12	14	[7.3]
European red mite, European fruit lecanium		§oil	2-3 gal/100 gal	12	0	[20.2]
Green Tip						
Apple Scab		Captan 50WP	1-2 lb/100 gal	24(E)	0	[2.1, 2.2]
		or Captan 80WP	0.65-1.25 lb/100 gal			
		or Captec or Captan 4L	0.5-1 qt/gal			
	OR	Dithane/Manzate/Maneb/ Penncozeb 75DF	1-2 lb/100 gal	24	BL,77(A)	[1.3, 2.2]
		or Polyram 80DF	1-2 lb/100 gal			
	OR	Vanguard 75WG	5 oz/A	12	72	
	OR	Scala 600SC	7-10 fl oz/A	12	72	
Fire blight		§Bordeaux mixture, 8-8-10				[8.4]
		(copper sulfate)	8 lb/100 gal	24	BL	
		(spray lime)	8 lb/100 gal			
	plus	(§oil)	1 qt/100 gal			
	OR	§Champ Flowable	1-2 qt/100 gal	24	BL	
	OR	§C-O-C-S	2-4 lb/100 gal	24	BL	
	OR	§Cuprofix MZ Disperss	3.3-6.6 lb/100 gal	24	HIG	
	OR	§Kocide 2000	2-4 lb/100 gal	24	HIG	
		or other copper products	see comments			
European red mite		§oil	2 gal/100 gal	12	0	[20.3]
Rosy apple aphid		*Lorsban 4EC	1 pt/100 gal	96	PB	[27.2]
		or Lorsban 75WG	0.3-0.67 lb/100 gal			
	OR	*Supracide 25WP	1-2 lb/100 gal	(E)	PB	
Half-Inch Green						
Apple scab		Same materials as Green Tip spray				[2.3]
	OR	Flint 50WG	0.67-0.8 oz/100 gal	12	14	[2.4, 2.14]
	OR	Sovran 50WG	1.0-1.6 oz/100 gal	12	30	
Dogwood borer, American plum borer		*Lorsban 4EC	1.5 qt/100 gal	96	28	[17.1]
		or Lorsban 50WS	1.5 lb/100 gal	96	28	
		or Lorsban 75WG	2 lb/100 gal	96	28	
European red mite		§oil	2 gal/100 gal	12	0	[20.4]
Redbanded leafroller		*Guthion 50WS	0.5 lb/100 gal	14-44 days (E)	14-21	[26.1]
Rosy apple aphid		Refer to Green Tip				[27.2]

Table 11.5.1. Pesticide Spray Table – Apples.

(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
San Jose scale		Esteem 35WP	4-5 oz/A	12	45	
		plus oil	2 gal/100 gal	12	0	
	OR	*Lorsban 4EC	1 pt/100 gal	96	PB	[28.3]
		or Lorsban 50WS	3 lb/A			
		or Lorsban 75WG	0.3-0.67 lb/100 gal			
	OR	§oil	2 gal/100 gal	12	0	
	OR	*Supracide 25WP	0.5 lb/100 gal	(E)	PB	
Tight Cluster						
Apple Scab		Captan 50WP	1-2 lb/100 gal	24(E)	0	
		or Captan 80WP	0.65-1.25 lb/100 gal			
		or Captec or Captan 4L	0.5-1 qt/gal			
	OR	Dithane/Manzate/Maneb/				
		Penncozeb 75DF	1-2 lb/100 gal	24	BL,77(A)	[2/2]
		or Polyram 80DF	1-2 lb/100 gal			
	OR	Flint 50WG	0.67-0.8 oz/100 gal	12	72	[2.4, 2.14]
	OR	Sovran 50WG	1.0-1.6 oz/100 gal	12	30	[2.4, 2.14]
	OR	either:				
		Nova 40WP	1.5-2 oz/100 gal	24	14	[2.5, 2.13]
		or Rubigan 1EC	3-4 fl oz/100 gal	12	30	
		or *Procure 50WS	3-4 oz/100 gal	12	14	
		plus either:				
		Captan 50WP	1 lb/100 gal	24 (E)	0	
		or Captan 80WP	0.65-1.25 lb/100 gal			
		or Captec or Captan 4L	1 pt/100 gal			
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/100 gal	24	BL,77(A)	
		or Polyram 80DF	1 lb/100 gal	24	BL,77(A)	
Powdery mildew		Topsin M70WP	4-8 oz/100 gal	12	0	[2.12]
	OR	Thiophanate-methyl 85WDG	3-5 oz/100 gal	12	0	[2.12]
	OR	*§JMS Stylet-Oil*	1-2% solution	12	0	[9.3]
	OR	Nova 40WP	1.5-2 oz/100 gal	24	14	
	OR	*Procure 50WS	3-4 oz/100 gal	12	14	
	OR	Rubigan 1EC	3-4 fl oz/100 gal	12	30	
	OR	§Sulfur 95WP	2 lb/100 gal	24	0	
		or §Sulfur 6F	2 pt/100 gal			
		or Sulfur, many other products; see label				
	OR	Bayleton/Triadimefon 50DF	1-2 oz/100 gal	12	45	[9.4]
	OR	Flint 50WG	0.67-0.8 oz/100 gal	12	14	
	OR	Sovran 50WG	1.0-1.6 oz/100 gal	12	30	
Dogwood borer, American plum borer		*Lorsban 4EC	1.5 qt/100 gal	96	28	[17.1]
		or Lorsban 50WS	1.5 lb/100 gal	96	28	
		or Lorsban 75WG	2 lb/100 gal	96	28	

Table 11.5.1. Pesticide Spray Table – Apples.

(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
European red mite		Apollo 4SC	1-2 oz/100 gal	12	45	[20.5]
	OR	§oil	1 gal/100 gal	12		[20.6]
	OR	Envidor 2SC	16-18 fl oz/A	12	7	
	OR	Savey 50DF	3 oz/A	12	28	[20.5]
	OR	Zeal 72WS	2-3 oz/A	12	14	[20.5]
Rosy apple aphid		Refer to Green Tip				[27.2]
San Jose scale		Refer to Half-Inch Green				[28.3]
Tarnished Plant bug	*OR*	*Asana XL 0.66EC	2-5.8 oz/100 gal		21	
	OR	Avaunt 30 WDG	5-6 oz/A	12	14	
	OR	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1L	2.0-2.4 fl oz/A	12	7	
	OR	*Danitol 2.4EC	10.67-16 fl oz/A	24	14	
	OR	*Pounce 3.2EC	4-16 fl oz/A	12	PF	
	OR	or *Pounce 25WP	6.4-25.6 oz/A			
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
Pink						
Apple rust diseases		Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/100 gal	24	BL,77(A)	[1.3]
		or Polyram 80DF	1 lb/100 gal	24	BL,77(A)	
	OR	Ferbam 76WDG	1-1.5 lb/100 gal	24	7	
	OR	Nova 40WP	1.5 oz/100 gal	24	14	
	OR	*Procure 50WS	3 oz/100 gal	24	14	
	OR	Rubigan 1EC	3 fl oz/100 gal	12	30	
	OR	Bayleton/Triadimefon 50DF	1-2 oz/100 gal	12	45	
Apple scab		Captan 50WP	1-21b/100 gal	24 (E)	0	[2.6, 2.7]
		or Captan 80WP	0.65-1.25 lb/l00 gal			
		or Captec or Captan 4L	0.5- I qt/100 gal			
	OR	Sovran 50WG	1.0 - 1.6 oz/100 gal	12	30	[2.4, 2.14]
	OR	Flint 50WG	0.67-0.8 oz/100 gal	12	14	[2.4, 2.14]
	OR	Topsin M 70WP	2-3 oz/100 gal	12	0	[2.12]
		plus either:				
		Captan 50WP	1 lb/100 gal	24(E)	0	
		or Captan 80WP	5/8 lb/100 gal			
		or Captec or Captan 4L	1 pt/100 gal			
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/100 gal	24	BL,77(A)	[2.2]
		or Polyram DF	1 lb/l00 gal	24	BL,77(A)	[2.2]

Table 11.5.1. Pesticide Spray Table – Apples.

(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Apple scab	*OR*	*either:*				
(continued)		Nova 40WP	1.5-2 oz/100 gal	24	14	[2.5, 2.13]
		or Rubigan 1EC	3-4 fl oz/100 gal	12	30	
		or *Procure 50WS	3-4 oz/100 gal	12	1	
		plus either:				
		Captan 50WP	1 lb/100 gal	24(E)	0	
		or Captan 80WP	5/8 Ib/100 gal			
		or Captec or Captan 4L	1 pt/l00 gal			
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/l00 gal	24	BL,77(A)	[2.2]
		or Polyram 80DF	1 Ib/100 gal	24	BL,77(A)	[2.2]
Black rot (frog-eye leafspot and fruit infections)		See comments				[4.2]
Blister spot		Aliette 80WDG	0.5-1.0 lb/100 gal	12	14	[5.1]
Powdery mildew		Same materials as Tight Cluster spray				[9.5]
Dogwood borer, American plum borer		*Lorsban 4EC	1.5 qt/100 gal	96	28	[17.1]
		or Lorsban 50WS	1.5 lb/100 gal	96	28	
		or Lorsban 75WG	2 lb/100 gal	96	28	
European red mite		Envidor, Savey, Zeal, or Apollo, same as Tight Cluster				[20.7]
	OR	*Vydate 2L	1-2 pt/100 gal	48	14	
	OR	Zeal 72WS	2-3 oz/A	12	14	[20.7]
Mullein plant bug		Actara 25WDG	4.5 oz/A	12	35	[22.3]
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	21	
	OR	Assail 30SG	4.0-8.0 oz/A	12	7	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
Rosy apple aphid		Actara 25WDG	4.5 oz/A	12	35	[27.3]
	OR	Assail 30SG	2.5-4.0 oz/A	12	7	
	OR	*Battalion 0.2EC	14.1 fl oz/A	12	21	
	OR	*Diazinon AG600	12.75 oz/100 gal	96	21	
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Lorsban 50WS	12 oz/100 gal	96	PB	
		or *Lorsban 4EC	1pt/100 gal		PB	
		or Lorsban 75WG	0.3-0.67 lb/100 gal			
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Thionex 50WP	1 lb/100 gal	24	21	
		or *Thionex 3EC	0.67 qt/100 gal			
	OR	*Vydate 2L	1-2 pt	48	14	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
Spotted tentiform leafminer, Apple blotch leafminer		Actara 25WDG	4.5 oz/A	12	35	[29.1]
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	21	
	OR	Assail 30SG	2.5 oz/A	12	7	

Table 11.5.1. Pesticide Spray Table – Apples.

(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Spotted tentiform leafminer, Apple blotch leafminer *(continued)*	*OR*	Avaunt 30WDG	5-6 oz/A	12	14	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	
	OR	*Baythroid 2E	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1L	2.0-2.4 fl oz/A	12	7	
	OR	*Calypso 4F	0.5-1.0 fl oz/100 gal	12	30	
	OR	*Danitol 2.4EC	10.67-16 fl oz/A	24	4	
	OR	*Pounce 3.2EC#	4-8 fl oz/A	12	PF	
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	48	14	
	OR	§Pyrenone 0.5EC	12 fl oz/A	12	1	
	OR	*Vydate 2L	1 pt/100 gal	48	14	
	OR	*Warrior 1CS	2.5-5.1 fl oz/A	24	21	
Tarnished plant bug		Refer to Tight cluster				[30.1]
Bloom						
Apple rust diseases		Refer to Pink spray for materials and comments				
Apple scab		Same materials and rates as Pink spray				
Black rot		Captan, Sovran, Flint, Topsin M, Thiophanate-methyl	same rates as for scab, mildew and rusts			[4.2]
Blister spot		Aliette 80WDG	0.5-1.0 lb/100 gal	12	14	[5.1]
Blossom end rot		Captan, Sovran, Flint, Scala, Vangard, Topsin M, Thiophahate-methyl	same rates as for scab, mildew and rusts			[6.2]
Fire blight (Blossom blight)		§Agrimycin 17WP or Streptrol 17WP or Firewall 17WP	0.5 lb/100 gal	12	50	[8.3]
	OR	§Agrimycin 17WP or Streptrol 17WP or Firewall 17WP *plus* Glycerine *either* (CP or USP grade) or Regulaid	0.25 lb/100 gal 2 qt/100 gal of finished spray (do not concentrate) 1 pt/100 gal of finished spray (do not concentrate)	12	50	
	OR	Serenade ASO	2-6 qt/A	4	0	[8.7]
Fire blights (Shoot blight)		Apogee 27.5DF	4.5-9 oz	12	45	[8.6]
Powdery mildew		Same as Tight Cluster sprays				[9.2, 9.3]
Codling moth		Isomate-C TT	200 dispensers/A			[14.2]
Mullein plant bug		Assail 30SG	4.0-8.0 oz/A	12	7	[22.4]
	OR	*Calypso 4F	0.5-1.0 fl oz/100 gal	12	30	
Obliquebanded leafroller	*OR*	§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	§Javelin 7.5WDG	0.13-1 lb/100 gal	4	0	
	OR	*Intrepid 2F	8-16 oz/A	4	14	

Table 11.5.1. Pesticide Spray Table – Apples.

(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Petal Fall						
Apple rust diseases		Refer to Pink sprays for materials and comments				[4.2]
Apple scab		*Captan 50WP*	1-2 lb/100 gal	24(E)	0	[2.7]
		or Captan 80WP	0.65-1.25 lb/l00 gal			
		or Captec or Captan 4L	0.5- 1 qt/100 gal			
	OR	or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/100 gal	24	77	[2.7]
		or Polyram 80DF	1 lb/l00 gal			
	OR	Flint 50WG	0.67-0.8 oz/100 gal	12	14	[2.4, 2.14]
	OR	Sovran 50WG	1.0-1.6 oz/100 gal	12	30	[2.4, 2.14]
	OR	Topsin M 70WP	2-3 oz/100 gal	12	0	[2.12]
		plus either:				
		Captan 50WP	1 lb/100 gal	24(E)	0	
		or Captan 80WP	5/8 lb/100 gal			
		or Captec or Captan 4L	1 pt/100 gal			
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/100 gal	24	77	[2.7]
		or Polyram 80DF	1 lb/l00 gal	24	77	
	OR	*either:*				
		Nova 40WP	1.5-2 oz/100 gal	24	14	[2.5, 2.13]
		or Rubigan 1EC	3-4 fl oz/100 gal	12	30	
		or *Procure 50WS	3-4 oz/100 gal	12	14	
		plus either:				
		Captan 50WP	1 lb/100 gal	24(E)	0	
		or Captan 80WP	5/8 lb/100 gal			
		or Captec or Captan 4L	1 pt/l00 gal			
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/l00 gal	24	77	[2.7]
		or Polyram 80DF	1 Ib/100 gal	24	77	
Black rot		Captan, Sovran, Flint, Topsin M, Thiophanate-methyl	same rates as for scab, mildew and rusts			
Blossom end rot		Captan, Sovran, Flint, Scala, Vanguard, Topsin M, Thiophanate-methyl	same rates as for scab, mildew and rusts			[6.2]
Fire blight (Shoot blight)		Apogee 27.5D	6-12 oz	12	45	[8.6]
Powdery mildew		Same as Tight Cluster sprays				[9.2, 9.3]
Codling moth		Isomate-C TT (if not deployed during bloom)	200 dispensers/A			[14.2]
Comstock mealybug		Assail 30SG	4.0-8.0 oz/A	12	7	[15.2]
	OR	*Diazinon AG 600WBC	12.75 oz/100 gal	96	21	
		or *Diazinon 50WP	1 lb/100 gal			
	OR	*Provado 1.6F	2 oz/100 gal	12	7	

Table 11.5.1. Pesticide Spray Table – Apples.

(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Dogwood borer, American plum borer		*Lorsban 4EC	1.5 qt/100 gal	96	28	[17.1]
		or Lorsban 50WS	1.5 lb/100 gal	96	28	
		or Lorsban 75WG	2 lb/100 gal	96	28	
European apple sawfly		*Guthion, *Imidan, or Lorsban 75WG, same as for codling moth at this time				[18.1]
	OR	Actara 25WDG	4.5-5.5 oz/A	12	35	[18.2]
	OR	or Assail 30SG	5.0-8.0	12	7	
	OR	Avaunt 30WDG	5-6 oz/A	12	14	
	OR	*Baythroid 2E	2.4-2.8 fl oz/A	12	7	
		or *Baythroid XL 1L	2.4-2.8 fl oz/A	12	7	
	OR	*Calypso 4F	1-2 fl oz/100 gal	12	30	
	OR	*Lannate 2.4L#	1.5 pt/100 gal	72	14	
European red mite		Acramite 50WS	0.75-1.0 lb/A	12	7	[20.9]
	OR	*Agri-Mek 0.15EC	2.5-5 oz/100 gal	12	28	[20.8]
	OR	Apollo 4SC	1-2 oz/100 gal	12	45	
	OR	Envidor 2SC	16-18 fl oz/A	12	7	
	OR	Kanemite 15SC	31 fl oz/A	12	14	[20.9]
	OR	Kelthane 50WS	3-6 lb/A	48	7	
	OR	Nexter 75 WS	4.4-5.2 oz/A	12	25	[20.9]
	OR	Portal Miticide/Insecticide	1-2 pt/A	12	14	[20.9]
	OR	§PureSpray Green	1 qt-1.5 gal/100 gal	12	0	[20.10]
	OR	Savey 50DF	3-6 oz/A	12	28	
	OR	§Stylet-Oil	0.5-2 gal/100 gal	12	0	[20.10]
	OR	*Vendex 50WP	4-8 oz/100 gal	48	14	
	OR	Zeal 72WS	2-3 oz/A	12	14	[20.9]
Green fruitworms	*OR*	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	28	
	OR	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	1.4-2.0 fl oz/A	12	7	
		or *Baythroid XL 1L	1.4-2.0 fl oz/A	12	7	
	OR	*Danitol 2.4EC	16 fl oz/A	24	14	
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Lorsban 75WG	0.33-0.67 lb/100 gal	96	PF	
	OR	*Pounce 3.2EC	4-8 fl oz/A	12	PF	
		or *Pounce 25WP	6.4-25.6 oz/A			
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	48	14	
	OR	*Thionex 50WP	1 lb/100 gal	24	21	
		or *Thionex 3EC	0.67 qt			
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
Mullein plant bug		Actara 25WDG	4.5-5.5 oz/A	12	35	[22.3]
	OR	Assail 30SG	4.0-8.0 oz/A	12	7	
	OR	*Calypso 4F	0.5-1.0 fl oz/100 gal	12	30	

Table 11.5.1. Pesticide Spray Table – Apples.

(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Obliquebanded	*OR*	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	21	
leafroller	*OR*	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	2.4-2.8 fl oz/A	12	7	
		or *Baythroid XL 1L	2.4-2.8 fl oz/A	12	7	
	OR	§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	
	OR	*Danitol 2.4EC	16 fl oz/A	24	14	
	OR	Delegate 25WG	4.5-7 oz/A	4	7	
	OR	§Deliver 18WG	0.5-2 lb/A	4	0	
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	§Entrust 80WP	2-3 oz/A	4	7	
	OR	*Intrepid 2F	12-16 fl oz/A	4	14	
	OR	§Javelin 7.5WDG	0.13-1 lb/100 gal	4	0	
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Lorsban 75WG	0.33-0.67 lb/100 gal	96	PF	
	OR	*Pounce 3.2EC	4-16 fl oz/A	12	14	
		or *Pounce 25WP	6.4-25.6 oz/A			
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	48	14	
	OR	SpinTor 2SC	2.5 oz/100 gal	4	7	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
Oystershell scale		*Guthion Solupak	0.5 lb/100 gal	14-44 days (E)	14-21	[24.1]
	OR	*Sevin 80WS, 80S	1.25-3.75 lb/A	12	3	
		or Sevin XLR Plus 4EC	1.5-3 qt/A			
		or Sevin 4F	1.5-3 qt/A			
Plum curculio		Actara 25WDG	4.5-5.5 oz/A	12	35	[25.4]
	OR	Avaunt 30WDG	5-6 oz/A	12	14	[25.4]
	OR	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	2.4-2.8 fl oz/A	12	7	
		or *Baythroid XL 1L	2.4-2.8 fl oz/A	12	7	
	OR	*Calypso 4F	1-2 fl oz/100 gal	12	30	
	OR	*Danitol 2.4EC	16 fl oz/A	24	14	
	OR	*Guthion 50WS	0.5 lb/100 gal	14-44 days (E)	14-21	[25.2]
	OR	*Imidan 70WP	0.75-1 lb/100 gal	72	7	
	OR	Lorsban 75WG	0.33-0.67 lb/100 gal	96	PF	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Sevin 80WS, 80S	1.25-3.75 lb/A	12	3	
		or Sevin XLR Plus 4EC	1.5-3 qt/A			
		or Sevin 4F	1.5-3 qt/A			
	OR	§Surround 95WP	50 lb/100 gal	4	0	[25.3]
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	

Table 11.5.1. Pesticide Spray Table – Apples.

(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Redbanded leafroller	*OR*	*Baythroid 2E	2.4-2.8 fl oz/A	12	7	
		or *Baythroid XL 1L	2.4-2.8 fl oz/A	12	7	
	OR	§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	
	OR	§Deliver 18WG	0.5-2 lb/A	4	0	
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	*Guthion 50WS	0.5 lb/100 gal	14-44 days (E)	14-21	
	OR	*Imidan 70WP	0.75-1 lb/100 gal	72	7	
	OR	§Javelin 7.5WDG	0.13-1 lb/100 gal	4	0	
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Lorsban 75WG	0.33-0.67 lb/100 gal	96	PF	
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	48	14	
Rosy apple aphid		Assail 30SG	2.5-4.0 oz/A	12	7	[27.4]
	OR	*Calypso 4F	0.5-1.0 fl oz/100 gal	12	30	
	OR	*Diazinon AG600	12.75 oz/100 gal	96	21	
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Lorsban 75WG	0.33-0.67 lb/100 gal	96	PF	
	OR	*Provado 1.6F	2 oz/100 gal	12	7	
	OR	*Thionex 50WP	1 lb/100 gal	24	21	
		or *Thionex 3EC	0.67 qt/100 gal			
Spotted tentiform leafminer, Apple blotch leafminer		Actara 25WDG	4.5-5.5 oz/A	2	35	[29.2]
	OR	Assail 30SG	2.5 oz/A	12	7	
	OR	Avaunt 30WDG	5-6 fl oz/A	12	14	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	
	OR	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1L	2.0-2.4 fl oz/A	12	7	
	OR	*Calypso 4F	0.5-1.0 fl oz/100 gal	12	30	
	OR	*Danitol 2.4EC	10.67-16 fl oz/A	24	14	
	OR	*Lannate 2.4L#	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	48	14	
	OR	*Provado 1.6F	2 oz/100 gal	12	7	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
Tarnished plant bug	*OR*	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	21	
	OR	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1L	2.0-2.4 fl oz/A	12	7	
	OR	*Danitol 2.4EC	10.67-16 fl oz/A	24	14	

Table 11.5.1. Pesticide Spray Table – Apples.

(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Tarnished plant Bug *(continued)*	*OR*	*Pounce 3.2EC	4-8 fl oz/A	12	PF	
		or *Pounce 25WP	6.4-25.6 oz/A			
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Provado 1.6F	2 oz/100 gal	12	7	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
White apple leaf-hopper, Potato leafhopper		Actara 25WDG	2-2.75 oz/A	12	14	[32.1]
	OR	*Agri-Mek 0.15EC	2.5-5 oz/100 gal	12	28	
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	28	
	OR	Assail 30SG	2.5-4.0 oz/A	12	7	
	OR	Avaunt 30WDG	5-6 oz/A	12	14	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	
	OR	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	1.4-2.0 fl oz/A	12	7	
		or *Baythroid XL 1L	1.4-2.0 fl oz/A	12	7	
	OR	*Calypso 4F	0.5-1.0 fl oz/100 gal	12	30	
	OR	*Danitol 2.4EC	10.67-16 fl oz/A	24	14	
	OR	*Lannate 2.4L#	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Provado 1.6F	2 oz/100 gal	12	7	
	OR	*Sevin 80WS, 80S	1.5 lb/100 gal	12	3	
		or Sevin XLR Plus 4EC	0.5 qt/100 gal			
		or Sevin 4F	0.5 qt/100 gal			
	OR	*Thionex 50WP	1 lb/100 gal	24	21	
		or *Thionex 3EC	0.67 qt/100 gal			
	OR	*Vydate 2L#	1-2 pt/100 gal	48	14	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
Additional Summer Sprays						
Apple rust diseases		Refer to Pink sprays for materials and comments				
Apple Scab		Captan 50WP	1-2 lb/100 gal	24 (E)	0	[2.91]
		or Captan 80WP	0.65-1.25 lb/100 gal			
		or Captec or Captan 4L	0.5-1 qt/100 gal			
	OR	Dithane/Manzate/Maneb/ Penncozeb 75DF	1-2 lb/100 gal	24	77	[2.10]
		or Polyram 80DF	1 lb/100 gal			
	OR	Flint 50WG	0.67-0.8 oz/100 gal	12	14	[2.4, 2.14]
	OR	Sovran 50WG	1.0-1.6 oz/100 gal	12	30	[2.4, 2.14]
	OR	Pristine 38WP	14.5-18.5 oz/A	12	0	
	OR	Topsin M 70WP	4-8 oz/100 gal	12	0	[2.12]
		or Thiophanate-methyl 85WDG	3-5 oz/100 gal			

Table 11.5.1. Pesticide Spray Table – Apples.

(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Apple Scab		*plus either:*				
(continued)		Captan 50WP	1 lb/100 gal	24 (E)	0	
		or Captan 80WP	5/8 lb/100 gal			
		or Captec or Captan 4L	1 pt/100 gal			
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/100 gal	24	77	[2.10]
		or Polyram 80DF	1 lb/100 gal	24	77	
	OR	*either:*				
		Nova 40WP	1.5-2 oz/100 gal	24	14	[2.5, 2.13]
		or Rubigan 1EC	3-4 fl oz/100 gal	12	30	
		or *Procure 50WS	3-4 oz/100 gal	12	14	
		plus either:				
		Captan 50WP	1 lb/100 gal	24 (E)	0	
		or Captan 80WP	5/8 lb/100 gal			
		or Captan 4L	1 pt/100 gal			
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/100 gal	24	77	[2.10]
		or Polyram 80DF	1 lb/100 gal	24	77	
Bitter Rot		Captan 50WP	1-2 lb/100 gal	24 (E)	0	[3.1]
		or Captan 80WP	0.65-1.25 lb/100 gal			
		or Captec or Captan 4L	0.5-1 qt/100 gal			
Black rot, White rot		Captan 50WP	1-2 lb/100 gal	24 (E)	0	[4.3]
		or Captan 80WP	0.65-1.25 lb/100 gal			
		or Captec or Captan 4L	0.5-1 qt/100 gal			
	OR	Flint 50WG	0.5 oz/100 gal	12	14	[2.14]
	OR	Sovran 50WG	1.0-1.6 oz/100 gal	12	30	[2.14]
	OR	Pristine 38WP	14.5-18.5 oz/A	12	0	
	OR	Topsin M 70WP	4-8 oz/100 gal	12	0	[10.3, 10.4]
		plus either:				
		Captan 50WP	1 lb/100 gal	24 (E)	0	
		or Captan 80WP	5/8 lb/100 gal			
		or Captec or Captan 4L	1 pt/100 gal			
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/100 gal	24	77	[2.10]
		or Polyram 80DF	1 lb/100 gal	24	77	
Blister spot		Aliette 80WDG	0.5-1 lb/100 gal	12	14	[5.1]
Fire blight (Shoot blight)		Apogee 27.5DF	6-12 oz	12	45	[8.6]
(Shoot blight, after hailstorm ONLY)		Agrimycin 17WP	0.5 lb	12	50	[8.5]
Powdery mildew		Bayleton/Triadimefon 50DF	1-2 oz/100 gal	12	45	[9.4]
	OR	§JMS Stylet-Oil	1-2% solution	12	0	[9.3]

Table 11.5.1. Pesticide Spray Table – Apples.

(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Powdery mildew	*OR*	Nova 40WP	1.5-2 oz/100 gal	24	14	[2.11]
(continued)	*OR*	*Procure 50WS	3 oz/100 gal	12	14	
	OR	Rubigan 1EC	3 fl oz/100 gal	12	30	
	OR	Sovran 50WG	1.0-1.6 oz/100 gal	12	30	[2.14]
	OR	§Sulfur 95WP	2 lb/100 gal	24	0	
		or §Sulfur 6F	2 pt/100 gal			
Sooty blotch and Flyspeck		Topsin M 70WP	2-3 oz/100 gal	12	0	[10.1, 10.2]
		or Thiophanate-methyl 85WDG	4-8 oz/100 gal			
		plus either:				
		Captan 50WP	1 lb/100 gal	24 (E)	0	[10.3, 10.4]
		or Captan 80WP	5/8 lb/100 gal			
		or Captec or Captan 4L	1 pt/100 gal			
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/100 gal	24	77	[2.10]
		or Polyram 80DF	1 lb/100 gal	24	77	
	OR	Flint 50WG	0.67-0.8 oz/100 gal	12	14	
	OR	Pristine 38WP	14.5-18.5/A	12	0	
	OR	Sovran 50WG	1.0 - 1.6 oz/100 gal	12	30	[2.14]
	OR	Ziram 76DF, 76WDG	1 lb/100 gal	48	14	
	OR	Ziram 76DF, 76WDG	1 lb/100 gal	48	14	[10.5]
		plus Sulfur 95WP	2 lb/100 gal	24		
Apple aphid, Spirea aphid		Actara 25WDG	4.5-5.5 oz/A	12	35	[11.1]
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	28	
		Assail 30SG	2.5-4.0 oz/A	12	7	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	
	OR	*Battalion 0.2EC	14.1 fl oz/A	12	21	
	OR	*Calypso 4F	0.5-1.0 fl oz/100 gal	12	30	
	OR	*Danitol 2.4EC	16 fl oz/A	24	14	
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	§M-Pede 49L	2 gal/100 gal	12	0	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Provado 1.6F	2 oz/100 gal	12	7	
	OR	§Pyrenone 0.5EC	12 fl oz/A	12	1	
	OR	*Thionex 50WP	1 lb/100 gal	24	21	
		or *Thionex 3EC	0.67 qt/100 gal			
	OR	*Vydate 2L	1-2 pt/100 gal	48	14	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
Apple maggot		Assail 30SG	8 oz/A	12	7	[12.1]
	OR	Avaunt 30WDG	5-6 oz/A	12	14	
	OR	*Baythroid 2E	2.4-2.8 fl oz/A	12	7	
		or *Baythroid XL 1L	2.4-2.8 fl oz/A	12	7	

Table 11.5.1. Pesticide Spray Table – Apples.

(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Apple maggot	*OR*	*Calypso 4F	1-2 fl oz/100 gal	12	30	
(continued)	*OR*	*Danitol 2.4EC	16 fl oz/A	24	14	
	OR	*Guthion 50WS	0.5 lb/100 gal	14-44 days (E)	14	
	OR	*Imidan 70WP	0.75-1 lb/100 gal	72	7	
	OR	*Lannate 2.4L#	0.75 pt/100 gal	72	14	
	OR	§Surround 95WP	50 lb/100 gal	4	0	[12.2]
Apple rust mite		Kelthane 50WS	0.75-1.5 lb/100 gal	12	7	[13.2]
	OR	Nexter 75WS	5.2-10.7 oz/A	12	25	
Codling moth		Assail 30SG	4.0-8.0 oz/A	12	7	[14.1], [14.2] [14.4]
	OR	Avaunt 30WDG	5-6 oz/A	12	14	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	
	OR	*Baythroid 2E	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1L	2.0-2.4 fl oz/A	12	7	
	OR	§Biobit XL 2.1 FC	1.5-5.5 pt/A	4	0	
	OR	*Calypso 4F	1-2 fl oz/100 gal	12	30	
	OR	§Carpovirusine 0.99SC	7-13.5 fl oz/A	4	0	
	OR	Cyd-X 0.06SC	1-6 fl oz/A	4	0	
	OR	Delegate 25WG	4.5-7 oz/A	4	7	
	OR	§Deliver 18WG	0.5-2 lb/A	4	0	
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	§Entrust 80WP	2-3 oz/A	4	7	
	OR	*Guthion 50WS	0.5 lb/100 gal	14-44 days (E)	14	
	OR	*Imidan 70WP	0.75 lb/100 gal	72	7	
	OR	*Intrepid 2F	12-16 fl oz/A	4	14	
	OR	*Lannate 2.4L	1.5 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Rimon 0.83EC	20-40 fl oz/A	12	14	
	OR	Sevin XLR Plus, 4F	1-3 qt/A	12	3	
		or Sevin 80S, *80WS, 4F	1.25-3.75 lb/A			
	OR	SpinTor 2SC	2.5 oz/100 gal	4	7	
	OR	§Surround 95WP	50 lb/100 gal	4	0	[12.2]
Comstock mealybug		Assail 30SG	4.0-8.0 oz/A	12	7	[15.3]
	OR	*Diazinon 50WP	1 lb/100 gal	96	21	
	OR	*Provado 1.6F	2 oz/100 gal	12	7	
Cutworms		§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	[16.2]
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	*Lannate 2.4L#	0.75 pt/100 gal	72	14	
Dogwood borer, American plum borer		*Lorsban 4EC	1.5 qt/100 gal	96	28	[17.1]
		or Lorsban 50WS	1.5 lb/100 gal	96	28	
		or Lorsban 75WG	2 lb/100 gal	96	28	

Table 11.5.1. Pesticide Spray Table – Apples.

(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
European corn borer		§Dipel 10.3DF	0.5-2 lb/A	4	0	[19.2]
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
European red mite, Twospotted spider mite		Acramite 50WS	0.75-1.0 lb/A	12	7	[20.11]
	OR	*Agri-Mek 0.15EC	2.5-5 oz/100 gal	12	28	[20.8]
	OR	Apollo 4SC	1-2 oz/100 gal	12	45	[20.11]
	OR	Envidor 2SC	16-18 fl oz/A	12	7	
	OR	Kanemite 15SC	31 fl oz/A	12	14	[20.11]
	OR	Kelthane 50WS	3-6 lb/A	48	7	
	OR	Nexter 75 WS	4.4-5.2 oz/A	12	25	[20.11]
	OR	Portal Miticide/Insecticide	1-2 pt/A	12	14	[20.9]
	OR	Savey 50DF	3-6 oz/A	12	28	
	OR	§Stylet-Oil	0.5-2 gal/100 gal	12	0	[20.10]
	OR	*Vendex 50WP	4-8 oz/100 gal	48	14	
	OR	Zeal 72WS	2-3 oz/A	12	14	[20.11]
Obliquebanded leafroller	*OR*	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	21	
	OR	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	2.4-2.8 fl oz/A	12	7	
		or *Baythroid XL 1L	2.4-2.8 fl oz/A	12	7	
	OR	§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	
	OR	*Danitol 2.4EC	16 fl oz/A	24	14	
	OR	Delegate 25WG	4.5-7 oz/A	4	7	
	OR	§Deliver 18WG	0.5-2 lb/A	4	0	
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	§Entrust 80WP	2-3 oz/A	4	7	
	OR	*Intrepid 2F	12-16 fl oz/A	4	14	
	OR	§Javelin 7.5WDG	0.13-1 lb/100 gal	4	0	
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	12	
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	48	14	
	OR	SpinTor 2SC	2.5 oz/100 gal	4	7	
	OR	*Warrior 1SC	2.6-5.1 fl oz/A	24	21	
Oriental fruit moth, Lesser apple worm		*Asana XL 0.66EC	2-5.8 oz/100 gal	12	21	[14.2], [14.3]
	OR	Assail 30SG	5.0-8.0 oz/A	12	7	
	OR	Avaunt 30WDG	5-6 oz/A	12	14	
	OR	*Baythroid 2E	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1L	2.0-2.4 fl oz/A	12	7	
	OR	*Calypso 4F	1-2 fl oz/100 gal	12	30	
	OR	Delegate 25WG	4.5-7 oz/A	4	7	
	OR	*Guthion 50WS	0.5 lb/100 gal	14-44 days (E)	14-21 (E)	

Table 11.5.1. Pesticide Spray Table – Apples.

(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Oriental fruit	*OR*	*Imidan 70WP	0.75-1 lb/100 gal	72	7	
moth, Lesser	*OR*	*Intrepid 2F	12-16 fl oz/A	4	14	
apple worm	*OR*	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
(continued)	*OR*	Pheromone disruption:				[14.2]
		§3M Sprayable Pheromone for OFM	1.7 oz/A			
		or §Isomate-M 100	100 ties/acre			
Redbanded	*OR*	*Baythroid 2E	2.4-2.8 fl oz/A	12	7	
leafroller		or *Baythroid XL 1L	2.4-2.8 fl oz/A	12	7	
	OR	§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	
	OR	§Deliver 18WG	0.5-2 lb/A	4	0	
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	*Guthion 50WS	0.5 lb/100 gal	14-44 days (E)	14-21	
	OR	*Imidan 70WP	0.75-1 lb/100 gal	72	7	
	OR	§Javelin 7.5WDG	0.13-1 lb/100 gal	4	0	
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	48	14	
San Jose scale		Esteem 35WP	4-5 fl oz/A	24	45	[28.4]
	OR	*Guthion 50WS	8-10 oz/100 gal	14-44 days (E)	14-21	
	OR	*Imidan 70WP	0.75-1 lb/100 gal	72	7	
	OR	*Provado 1.6F	2 oz/100 gal	12	7	
Spotted tentiform leafminer, Apple blotch leafminer		Actara 25WDG	4.5-5.5 oz/A	12	35	[29.3]
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	28	
	OR	Assail 30SG	2.5 oz/A	12	7	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	
	OR	*Baythroid 2E	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1L	2.0-2.4 fl oz/A	12	7	
	OR	*Calypso 4F	0.5-1 fl oz/100 gal	12	30	
	OR	*Danitol 2.4EC	10.67-16 fl oz/A	24	14	
	OR	*Lannate 2.4L#	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	*Provado 1.6F	2 oz/100 gal	12	7	
	OR	*Vydate 2L#	0.5-1 pt/100 gal	48	14	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
Variegated leaf-		§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	[31.1]
roller, Sparganothis fruitworm	*OR*	§Deliver 18WG	0.5-2 lb/A	4	0	
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	§Javelin 7.5WDG	0.13-1 lb/100 gal	4	0	
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			

Table 11.5.1. Pesticide Spray Table – Apples.

(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
White apple		Actara 25WDG	2-2.75 oz/A	12	14	[32.1]
leafhopper,	*OR*	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	28	
Potato leafhopper	*OR*	Assail 30SG	2.5-4.0 oz/A	12	7	
	OR	Avaunt 30WDG	5-6 oz/A	12	14	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	
	OR	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	1.4-2.0 fl oz/A	12	7	
		or *Baythroid XL 1L	1.4-2.0 fl oz/A	12	7	
	OR	*Calypso 4F	0.5-1 fl oz/100 gal	12	30	
	OR	*Danitol 2.4EC	10.67-16 fl oz/A	24	14	
	OR	*Lannate 2.4L#	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Provado 1.6F	0.5-2 oz/100 gal	12	7	[32.2]
	OR	*Sevin 80WS, 80S	1.5 lb/100 gal	12	3	
		or Sevin XLR Plus 4EC	0.5 qt/100 gal			
		or Sevin 4F	0.5 qt/100 gal			
	OR	*Thionex 50WP	1 lb/100 gal	24	21	
		or *Thionex 3EC	0.67 qt/100 gal			
	OR	*Vydate 2L#	1-2 pt/100 gal	48	14	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
Woolly apple		Assail 30SG	4.0-8.0 oz/A	12	7	[33.1]
aphid	*OR*	*Diazinon 50WP	1 lb/100 gal	96	21	
	OR	*Thionex 50WP	1 lb/100 gal	24	21	
		or *Thionex 3EC	0.67 qt/100 gal			
Postharvest						
Crown rot (collar rot)		Ridomil Gold 4EC	see comments	12	see comments	[7.2]
Control of Storage Disorders						
Storage rots		Mertect 340F	1 pt/100 gal			[34.1]
		plus Captan 50WP	2.5 lb/100 gal			
		or Captan 80WP	1.6 lb/100 gal			
		or Captec or Captan 4L	1.25 qt/100 gal			
	OR	Scholar 50W	6-8 oz/100 gal			[34.1]
Storage scald		No Scald DPA-23	2.5-5 pt/100 gal			[35.1]
		or Shield Brite DPA				
Senescent break-down (McIntosh)		Dowflake Process Grade	25 lb/100 gal			[36.1]

11.6 Growth Regulator Use In Apples

11.6.1 Chemical Thinning

Fruit thinning is a management practice that reduces yield in the current season but results in increased fruit size and also increased return bloom and yield in the next season. Large fruit size is best obtained with consistent cropload reductions each year through chemical thinning. The use of growth regulating chemicals to thin apple trees is not an exact science and each grower must weigh and evaluate the many factors that affect chemical thinning response in deciding on a thinning program. Although the recommendations in this section are based on research and experience, growers are cautioned that their success with chemical thinning depends on many factors, and they should use these recommendations only as a guide.

11.6.2 Weather Factors That Affect Thinning Response

Frost. Frost before application of thinners can greatly increase the amount of thinning obtained from chemical thinners. Frost at bloom can damage fruitlets and reduce seed set, which can result in increased natural drop and greater chemical thinning response. Frost can also damage spur leaves, resulting in greater chemical uptake and reduced photosynthesis, thus greater thinning response. Wherever flowers and leaves have been damaged by frost, extreme caution should be used with chemical thinners. Typically, lower rates would be used in such cases.

Sunlight Levels before Application. The amount of sunlight for the 3–5 days preceding application of chemical thinners has an important effect on chemical uptake and response. Intense cloudy weather before application of thinners can result in increased chemical uptake and greater thinning response, due to greater succulence of the leaves and a thin wax cuticle. This results in increased natural drop and greater chemical thinning response. Growers may want to reduce the rate of thinner used, if intense cloudy weather precedes application.

Temperature at Time of Application. The uptake of chemical thinners is greater at higher temperatures than at lower temperatures. The optimum is between 70–80° F. Above 80° F, uptake is substantially greater than below 80° F. The time of day applications are made appears to be unimportant. Applications made in the morning or evening when it is cool have a longer drying time on the leaf, resulting in a slow but sustained uptake of chemical, while at higher temperatures during mid-day, drying times are shorter, resulting in a short but rapid uptake of chemical. Thus, the total amount of chemical taken into the plant appears to be very similar regardless of the time of day. Recent research results also indicate that similar thinning is achieved regardless of the time of day applications are made.

Weather After Application. Temperature and sunlight levels for the 5-day period after application of thinners are the predominant weather factors affecting chemical thinning response. The interaction of temperature and sunlight with the chemical thinner creates stress in the tree, which is necessary to make some fruit drop off. Warmer temperatures increase thinning response, while greater light levels decrease thinning response (Fig. 11.6.1).

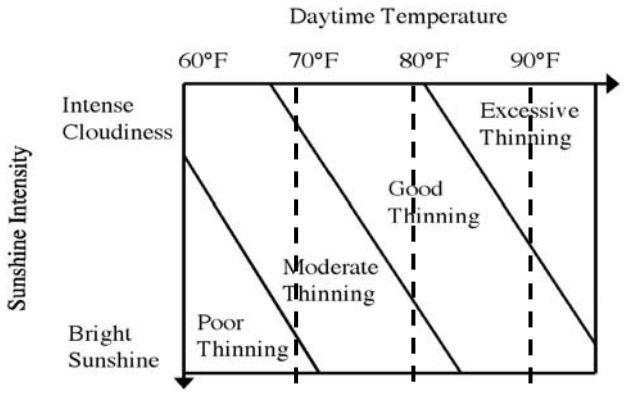


Figure 11.6.1. The interaction of temperature and sunlight intensity on thinner action.

Night temperatures are also an important factor to consider. Warm night temperatures (>60° F) give greater thinning response. With high night temperatures, fruits use up the carbohydrates that were produced during the day at a fast rate, resulting in a deficit of resources for fruit growth and causing the weakest fruits to drop. The greatest thinning can result if warm night temperatures are combined with intense cloudy/warm daytime weather. Under these conditions, the tree produces little reserves during the day and at night the fruits use up all of the reserves produced during the day, making the fruits very susceptible to the stress caused by chemical thinners. Under these conditions, excessive fruit drop can result. The least effective thinning is achieved when bright, warm daytime weather is accompanied by low night temperatures. Under these conditions, the tree produces large amounts of carbohydrates during the day and the fruits use them up at a slow rate during the night. Under these conditions, there is little stress created by chemical thinners and the thinning response is poor. Growers should critically examine the weather forecast for the 3–7-day period following application of thinners and adjust rates of chemical thinners up or down 50% based on forecasted temperatures and sunlight levels.

11.6.3 Tree Factors that affect Thinning Response

Pollination. Poor cross-pollination results in low viable seed number per fruit, greater post-bloom fruit drop and greater sensitivity to chemical thinners. In contrast, high seed numbers per fruit result in more difficult-to-thin conditions. In general, if seed numbers are less than 5, thinning rates should be reduced.

Initial Cropload (Fruit Set). A high initial cropload usually results in a relatively high final cropload, regardless of chemical thinning program. Therefore, to achieve a given cropload each year, the initial cropload must be considered when determining the aggressiveness of the thinning program. Growers should use a more aggressive thinning program when initial fruit set is high and a less aggressive thinning program when initial fruit set is lower.

Fruit Size at Time of Application. Fruitlets are more sensitive to NAA and BA at 8-12mm fruit diameter than at smaller or larger sizes. In warm years, when fruit growth rate is rapid, chemical thinners should be applied slightly before fruits reach 10 mm diameter (8-10 mm). In cool years, when fruit growth rate is slow, the application of chemical thinners should be delayed until fruits are 12-15 mm in diameter. Growers should attempt to time chemical thinner application according to a suitable weather window within the preferred fruit size windows. It is generally better to delay application of a thinner until favorable weather if forecast after application than to apply a thinner at the suggested fruit size and have cool weather follow for several days.

Sensitivity of the Tree. The internal physiological status of the tree determines its sensitivity to chemical thinners. Growers should use a less aggressive thinning program under conditions when tree carbohydrate supply for the fruitlets is expected to be low, and a more aggressive thinning program when tree carbohydrate supply is expected to be high. The carbohydrate supply available to the fruitlets is reduced by: 1) heavy croploads the previous year. 2) cloudy weather after application of chemical thinners. 3) heavy insect and disease damage to foliage during the previous season. 4) severe winter temperatures that damage vascular tissues necessary for the transport of reserves from the root to the top in the spring. 5) warm temperatures in late winter and early spring (Feb. 15–April 15), which cause the tree to use its carbohydrate reserves before bloom.

11.6.4 Chemicals Registered for Thinning

Naphthaleneacetic acid (NAA) is an auxin-type growth regulator that induces fruit thinning at rates from 2.5–15 ppm depending on variety. In some years, however, there is very little difference in response between 5 ppm and 10 ppm. NAA has some thinning activity from full bloom until fruits are 15 mm in diameter, with the optimum thinning activity when fruit diameter is between 8-12 mm fruit size. It is sold as either the Sodium salt (Fruitone-N, Fruitone-L) or the Potassium salt (K-Salt Fruit Fix-200 and Fruit Fix-800). The four formulations give very similar thinning responses if used at the same rate of NAA. NAA stimulates ethylene production in the tree and at high concentrations also inhibits photosynthesis and fruit growth rate for a period of 7–10 days after application. The inhibition of fruit growth rate results in abscission of the weaker fruit on the tree. At early timings such as full bloom or petal fall, there appears to be little negative impact on fruit growth rate from NAA, which results in more modest thinning than at later timings. In some years and with some varieties like Empire, the temporary inhibition of fruit growth caused by NAA results in little gain in final fruit size at harvest even if thinning is achieved. This negative side effect is most common if NAA is applied at rates greater than 10 ppm, when temperatures are high and at fruit sizes larger than 10 8 mm. High rates of NAA should be avoided on small fruited varieties. High rates of NAA may also cause pygmy fruit with Delicious and Fuji.

Naphthaleneacetamide (NAD or NAAm) is an amide form of NAA but has much lower activity than NAA. As a consequence, it is a mild but safe thinner that is used at rates from 25–50 ppm. Late timings result in pygmy fruit with Delicious, and are ineffective with other varieties. It is often used at petal fall on early ripening varieties and on certain hard-to-thin varieties such as Macoun.

6-Benzyladenine (BA) is a cytokinin-type growth regulator that induces fruit thinning at rates from 35–150 ppm. BA can be used from petal fall to approximately 15 mm fruit size, but the thinning response is poor when applied at petal fall and its effectiveness at larger fruit sizes is diminished unless favorable weather conditions following application. The best response is when fruits are 10–12 mm in diameter. It is most effective when temperatures are warm (70°F) for a 3–5-day period after application. It is sold in three formulations as either Maxcel (1.9% BA), or RiteWay (1.9% BA) or Exilis Plus (2.0% BA). The primary advantage of BA is that it results in larger fruit size than with other thinners due to a stimulation of cell division. The primary disadvantage of BA is that it often does not thin adequately by itself. Where more aggressive thinning is desired, carbaryl should be combined with BA. In some cases, the use of BA alone has resulted in significant fruit size improvement even though there was little thinning.

Carbaryl is a carbamate insecticide that also has moderate thinning action. It is relatively safe and has the added advantage of having good insecticidal properties on leafhoppers and plum curculio. It is relatively rate-insensitive, with similar thinning response from 0.25 lb up to 1.0 lb A.I./100 gallons. One of its best features is that it selectively removes the weaker fruits within the cluster, leaving predominantly one fruit per cluster. Carbaryl has been shown to enhance the effectiveness of NAA or BA when used in a tank mix. It is commonly used in combination with NAA or BA. If there is satisfactory bloom and pollination weather we recommend that a thinning program start with a petal fall spray of carbaryl at a minimum. It is important that bee are removed from the orchard before carbaryl is applied. Recent research indicates that the major mite predator mite in N.Y. (*Typhlodromus pyri*) has developed resistance to carbaryl. Thus, Carbaryl can be used in N.Y. without disrupting biological mite control programs. Carbaryl is very toxic to bees and the wettable powder particles of Carbaryl, which

are similar in size to pollen grains, can be picked up by bees and carried back to the hive. The liquid formulations of carbaryl are not picked up as easily by bees, so their use is much safer. The liquid formulations have made it possible to apply Carbaryl at a wide range of timings from petal fall to 20 mm fruit size. The liquid formulations of carbaryl have significant amounts of added surfactants and thus have greater thinning activity than the wettable powder formulations. Under cloudy, rainy weather conditions, the liquid formulations may cause fruit skin damage, especially when foliar nutrients or captan are included in the thinning spray. With cloudy, rainy weather, we recommend the wettable powder formulations. With bright sunshine, we recommend the liquid formulations.

Vydate is a broad spectrum carbamate insecticide that also has moderate thinning activity. It is similar to carbaryl in thinning action and is used from 0.25 to 1.0 lb A.I./100 gallons. It is not commonly used in New England for thinning since it is reported to be more toxic to predator mites. However, in pest control programs that do not attempt to conserve predatory mites, Vydate can be useful as both a thinning agent and a broad spectrum insecticide. Like carbaryl, it is usually combined with NAA and BA for greater thinning.

Ethephon (Ethrel) is a growth regulator that stimulates ethylene production by the plant. It can be used to thin apple trees from full bloom to 20 25 mm fruit size. It has given unpredictable thinning action. In some cases it has defruited the trees. Nevertheless, it does have the advantage that it will thin large fruit (up to 25 mm). In general, a rate of 200 to 300 ppm (.66 to 1.0 pt/100 gal tree row volume dilute) is the use range that we suggest. Ethrel also has a significant positive effect on return bloom in addition to the thinning effect. Ethrel can also be used as a return bloom enhancer after the thinning period is over. For this use, it is applied at low rates after the window for thinning has passed (usually 4-6 weeks after full bloom).

Wilthin is a caustic chemical thinner that works by burning flower parts of unpollinated flowers, thus preventing their pollination and fertilization. It must be applied at a specific timing (50% full bloom) when the king blossoms have been pollinated but the lateral flowers have not. It should also be applied with a spreader/sticker such as Regulaid. The major disadvantage to Wilthin is that it must be applied before the crop is set. However, Wilthin has proven to be a relatively mild and safe thinner, removing only about 10–20% of the crop. With high rates and slow drying conditions, Wilthin can cause fruit injury (marking and russetting), especially on Gala and Fuji.

11.6.5 Chemicals not Registered for Thinning that Influence Cropload

Lime sulfur is a foliar fungicide that, if used during bloom or during the early post-bloom period at rates of 2.5–3 gal/100 gal, will cause significant thinning. Lime sulfur in combination with oil or fish oil is used increasingly in organic apple production systems. Growers who use lime sulfur should account for the thinning action of this material when they develop their thinning programs.

Ammonium Thiosulfate (ATS) is a foliar nitrogen fertilizer that, if used during bloom at rates of 2–4 gal/100 gal, may cause significant thinning. Growers who use ATS should account for the thinning action of this material when they develop their thinning programs.

Oil or Fish oil are foliar insecticides that also significantly enhance chemical thinner response. Combinations of lime sulfur and oil (2%) or carbaryl and oil (0.25%) or BA and carbaryl and oil (0.25%) give greater thinning than either product alone.

11.6.6 Spray Timings

Chemical thinning can be done at various times depending on the chemical used, beginning with full bloom and ending when fruits have reached 20 mm in diameter. The following five timing windows during the growing season should be considered when applying thinners.

50% Bloom. Bloom thinning can be done with caustic thinning chemicals such as Wilthin or ATS or with hormone-type thinners such as NAA. The timing window with caustic thinners is very narrow (1–2 days) since the goal is to allow the king bloom to be pollinated and then apply the chemical to prevent further pollination of other flowers. Thinning response with the caustic blossom thinners is not weather-dependent, but fruit skin injury can occur with high rates and slow drying conditions. Use of NAA at full bloom may give a moderate thinning response.

Petal Fall (1 week after full bloom). Thinning at petal fall has the advantage of allowing some assessment of pollination before making the decision about aggressiveness of thinning. As with bloom thinning, the objective is to remove a portion of the crop before competition between fruits reduces fruit size. In addition, after petals have fallen and bee hives have been removed from the orchard, carbaryl can be used as a thinner. Thinning response with NAA, carbaryl or BA at petal fall is usually moderate, thus the petal fall timing can be viewed as safe. Petal fall sprays alone are unlikely to provide adequately thinning in most years. Petal fall sprays are usually used as part of a multi-spray program, which allows a portion of the crop to be removed at petal fall and the balance of the thinning done 7–10 days later at 10-12 mm fruit diameter.

8–14 mm fruit size (2–3 weeks after full bloom). The traditional time to apply chemical thinners (hormone-type thinners) is when king fruits are 10 mm in diameter. By that time, growers can accurately assess fruit set. Growers should apply chemical thinners anytime when king fruits are between 8 and 13 mm when there is a satisfactory weather window as outlined above. When fruit diameter

exceeds 15 mm, the effectiveness of NAA and BA declines rapidly. The major disadvantage of waiting until the 10 mm timing is that this limits growers to only one opportunity to reduce cropload, and if poor weather conditions result in poor thinning, then expensive hand thinning will be required. By using multiple spray timings, a grower has several chances to thin the trees.

15–20 mm fruit size (3–4 weeks after full bloom). Thinning when fruits are larger than 15 mm should only be done on an emergency or rescue basis when earlier attempts to reduce cropload have failed. Ethrel with oil or carbaryl with oil as an adjuvant can be used for this purpose although the thinning outcome may be variable.

15-25 mm fruit size. 200 to 300 ppm ethephon plus surfactant at this time may be used as a 'rescue' thinning treatment if not enough thinning has already been observed. This treatment has had variable results and may not always work – use caution. Hand thinning may be more desirable at this timing. See http://www.umass.edu/fruitadvisor/factsheets/F-129.pdf for more details.

4-6 weeks after full bloom. With some varieties that are strongly biennial in their cropping pattern, an additional 3 chemical sprays are useful to enhance repeat bloom the following year without causing additional thinning. This is done once fruitlets have exceeded 20 mm in diameter, when they are less susceptible to chemical thinners. Low doses of Ethephon (Ethrel) or NAA have a positive effect on repeat bloom without causing additional thinning when used at 4-6 weeks after bloom. This treatment is particularly useful on large-fruited varieties that are biennial.

11.6.7 Suggested Strategies For New England Growers

The myriad of possible combinations of chemicals, timings, rates and varieties provides a great number of possible thinning programs for growers. We suggest three basic thinning programs.

1. **Easy-to-thin varieties.** For easy-to-thin varieties like McIntosh, Cortland, Gingergold, Mutsu, Idared and Granny Smith a petal fall application of carbaryl is recommended. This may be all that is required in some circumstances. If additional thinning appears necessary an application at the 8-13 mm fruit stage is appropriate. Our suggested approach is to use carbaryl at 0.5 lb AI/100 and then add either NAA or BA at a rate that fits the variety, fruit set and environmental conditions. See Table 11.6.2 for specific variety recommendations.
2. **Multiple spray applications.** For hard-to-thin varieties like Empire, Gala, Jonamac, Macoun, Spur Delicious, Golden Delicious, Spur Rome, Fuji etc., we recommend multiple applications. With two or three opportunities to thin the trees, risks associated with over or under thinning are reduced. We suggest growers apply either a Bloom Spray or a Petal Fall Spray and then follow with a second spray at the 8–14 mm stage. A third spray, if needed, could be applied at the 15–20 mm stage. See Table 11.6.2 for specific recommendations.
3. **Single or Multiple Applications followed by repeat bloom enhancer.** This program is used where expected repeat bloom is insufficient. It is useful for easy-to-thin biennial triploid varieties such as Jonagold and Mutsu and it is also useful for hard-to-thin, strongly biennial varieties such as Fuji and Golden Delicious. We suggest applying chemical thinners at the normal timing and then following with 3 weekly sprays of Ethrel or NAA about 4–6 weeks after bloom. See Table 11.6.2 for specific recommendations.

11.6.8 Summary

- The time of day when thinning applications are made has little effect on thinning response, thus, growers should not be too concerned about the temperature at time of application.
- Dark, cloudy weather for 2 or more days after application of thinners will increase thinning response; therefore, growers should reduce the rate of thinner if intense cloudy weather follows application.
- High night temperatures (>60° F) and high day temperatures (>85° F) after application of thinners will increase thinning response; thus, growers should critically examine the weather forecast for the 3–5-day period following application of thinners to adjust rates of chemicals used based on forecasted night and daytime temperatures and sunlight levels.
- High initial fruit set will result in greater final fruit set in most years, despite the application of thinners. A lower initial fruit set will result in lower final fruit numbers; therefore, growers should use a more aggressive thinning program when initial fruit set is high and a less aggressive thinning program when initial fruit set is low.
- Optimum application timing of chemical thinners is when fruit size is 8–10 mm in warm years and 12–15 mm in cold years given favorably warm temperatures follow application.
- Growers should attempt to time chemical thinner applications according to a suitable weather window within the desired fruit size range.
- High rates of NAA reduce fruit growth rate and should be avoided on small-fruited varieties such as Empire, Jonamac and Gala.
- BA alone is a mild thinner and should always be used in combination with carbaryl when thinning is desired.
- Return bloom can be enhanced by late June and early July applications of Ethrel or NAA.
- To reduce the risk of over thinning or under thinning, a multiple spray program should be employed on hard-to-thin varieties.

Table 11.6.1. Chemicals registered for use in apple thinning in New England.

Timing	Chemical	Commercial Product Name	Typical rates of formulated product/100 gallons based on a full TRV gallonage per acre	Max. rate of formulated product/acre
Bloom	Ammonium Thiosulfate	ATS (foliar nutrient)	2-4 gal	–
Petal Fall	Naphthaleneacetamide	Amid-Thin W	4-8 oz (25-50ppm)	2 lb
	Naphthaleneacetic Acid-Sodium	Fruitone-N, Fruitone-L	2-4 oz (5-10ppm)	16 oz
	Carbaryl	Sevin XLR Plus	0.5-1.5 pt	6 pt
	Carbaryl	Sevin 4F	0.5-1.5 pt	6 pt
8-13mm	Benzyladenine	Maxcel	32-64 fl oz	308 fl oz
Fruit Size	Benzyladenine	Exilis Plus	29-58 fl oz	296 fl oz
	Benzyladenine plus GA 4+7	RiteWay	32-64 fl oz	308 fl oz
	Naphthaleneacetic Acid-Sodium	Fruitone-N, Fruitone-L	2-6 oz (5-15ppm)	24 oz
	Carbaryl	Sevin XLR Plus	0.5-1.5 pt	6 pt
	Carbaryl	Sevin 4F	0.5-1.5 pt	6 pt
	Carbaryl	Sevin 80 WSP	0.3-0.9 lb	3.6 lb
15-20mm	Ethephon	Ethrel	1-1.5 pt (300-450ppm)	6 pt
Fruit Size	Carbaryl	Sevin XLR Plus	0.5-1.5 pt	6 pt
	Carbaryl	Sevin 4F	0.5-1.5 pt	6 pt
	Carbaryl	Sevin 80 WSP	0.3-0.9 lb	3.6 lb
15-25mm	Ethepon plus surfactant	Ethrel	250-300ppm	6 pt
Fruit Size				

*Tree Row Volume Gallonage (TRV) = (Tree Height X Tree Width X 43,560 X 0.7) / (Between Row Spacing X1,000).

Table 11.6.2. Recommendations for thinning specific apple varieties in New England.

The chemicals and rates suggested in this table are the "best suggestion" of the authors for mature trees with a heavy fruit set and "normal" fruit thinning weather. Our rates should be adjusted up or down by 50% depending on weather conditions, pollination, fruit set and tree sensitivity. Other chemicals, rates, timings and combinations may also work.

	APPLICATION TIMING			
	50% Full Bloom	Petal Fall (1 week after bloom)	8-14 mm fruit size (2-3 weeks after bloom)	Return Bloom Enhancer (4-6 weeks after bloom)
VARIETY	*Rates are per 100 gallons based on a full dilute TRV application**			
Ben Davis			3 oz Fruitone-N* plus 1 pt Sevin	
Cameo		1 pt Sevin	3 oz Fruitone-N plus 1 pt Sevin	
Cortland			2 oz Fruitone-N	
Delicious (Spur Type)	2 gal ATS	1 pt Sevin	64 oz 6-BA plus 1 pt Sevin plus 1 qt Ultrafine spray oil **OR** 3 oz Fruitone-N plus 1 pt Sevin	
Delicious (Non-Spur Type)	2 gal ATS		48 oz 6-BA plus 1 pt Sevin **OR** 2 oz Fruitone-N plus 1 pt Sevin	
Early McIntosh		5 .5 oz Amide Thin plus 1 pt Sevin		
Empire		2 oz Fruitone-N plus 1 pt Sevin	64 oz 6-BA plus 1 pt Sevin **OR** 3 oz Fruitone-N plus 1 pt Sevin	
Fortune		2 oz Fruitone-N plus 1 pt Sevin	3 oz Fruitone-N plus 1 pt Sevin	0.5 pt Ethrel (3 weekly sprays) **OR** 2 oz Fruitone-N (3 weekly sprays)
Fuji	2 gal ATS	1 pt Sevin	64 oz 6-BA plus 1 pt Sevin	0.5 pt Ethrel (3 weekly sprays) **OR** 2 oz Fruitone-N (3 weekly sprays)
Gala	2 gal ATS	1 pt Sevin	64 oz 6-BA plus 1 pt Sevin	
Gingergold			2 oz Fruitone-N plus 1 pt Sevin	
Golden Delicious (without use of Provide)	2 gal ATS	3 oz Fruitone-N plus 1 pt Sevin	64 oz 6-BA plus 1 pt Sevin **OR** 6 oz Fruitone-N plus 1 pt Sevin	0.5 pt Ethrel (3 weekly sprays) **OR** 2 oz Fruitone-N (3 weekly sprays)

Table 11.6.2. Recommendations for thinning specific apple varieties in New England.

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	APPLICATION TIMING			
	50% Full Bloom	**Petal Fall (1 week after bloom)**	**8-14 mm fruit size (2-3 weeks after bloom)**	**Return Bloom Enhancer (4-6 weeks after bloom)**
VARIETY	***Rates are per 100 gallons based on a full dilute TRV application****			
Golden Delicious (with use of provide)	2 gal ATS	1 pt Sevin	48 oz 6-BA plus 1 pt Sevin **OR** 4 oz Fruitone-N plus 1 pt Sevin	0.5 pt Ethrel (3 weekly sprays) **OR** 2 oz Fruitone-N (3 weekly sprays)
Granny Smith			2 oz Fruitone-N plus 1 pt Sevin	
Honeycrisp	2 gal ATS	2 oz Fruitone-N plus 1 pt Sevin	3 oz Fruitone-N plus 1 pt Sevin	2 oz Fruitone-N (3 weekly sprays)
Idared			2 oz Fruitone-N plus 1 pt Sevin	
Jerseymac		2 oz Fruitone-N plus 1 pt Sevin	3 oz Fruitone-N plus 1 pt Sevin	
Jonagold			3 oz Fruitone-N plus 1 pt Sevin	0.5 pt Ethrel (3 weekly sprays) **OR** 2 oz Fruitone-N (3 weekly sprays)
Jonamac		3 oz Fruitone-N plus 1 pt Sevin	64 oz 6-BA plus 1 pt Sevin **OR** 3 oz Fruitone-N plus 1 pt Sevin	
Jonathan			2 oz Fruitone-N plus 1 pt Sevin	
Lady Apples		2 oz Fruitone-N plus 1 pt Sevin	4 oz Fruitone-N plus 1 pt Sevin	
Liberty		3 oz Fruitone-N plus 1 pt Sevin	64 oz 6-BA plus 1 pt Sevin **OR** **3** oz Fruitone-N Plus 1 pt Sevin	
Lodi		5.5 oz Amide Thin plus 1 pt Sevin		

Table 11.6.2. Recommendations for thinning specific apple varieties in New England.

The chemicals and rates suggested in this table are the "best suggestion" of the authors for mature trees with a heavy fruit set and "normal" fruit thinning weather. Our rates should be adjusted up or down by 50% depending on weather conditions, pollination, fruit set and tree sensitivity. Other chemicals, rates, timings and combinations may also work.

	APPLICATION TIMING			
	50% Full Bloom	**Petal Fall (1 week after bloom)**	**8-14 mm fruit size (2-3 weeks after bloom)**	**Return Bloom Enhancer (4-6 weeks after bloom)**
VARIETY	***Rates are per 100 gallons based on a full dilute TRV application****			
Macoun	2 gal ATS	3 oz Fruitone-N plus 1 pt Sevin	64 oz 6-BA plus 1 pt Sevin **OR** 4 oz Fruitone-N plus 1 pt Sevin	2 oz Fruitone-N (3 weekly sprays)
Milton			2 oz Fruitone-N plus 1 pt Sevin	
McIntosh (Non Spur Type)			2 oz Fruitone-N plus 1 pt Sevin **OR** 40 oz 6-BA plus 1 pt Sevin	
McIntosh (Spur Type)			3 oz Fruitone-N plus 1 pt Sevin OR 48 oz 6-BA plus 1 pt Sevin	
Mutsu (Crispin)			2 oz Fruitone-N plus 1 pt Sevin	0.5 pt Ethrel (3 weekly sprays) **OR** 2 oz Fruitone-N (3 weekly sprays)
Northern Spy			2 oz Fruitone-N plus 1 pt Sevin	0.5 pt Ethrel (3 weekly sprays) **OR** 2 oz Fruitone-N (3 weekly sprays)
NY674		2 oz Fruitone-N plus 1 pt Sevin	3 oz Fruitone-N plus 1 pt Sevin **OR** 64 oz 6-BA plus 1 pt Sevin	
Paulared		2 oz Fruitone-N plus 1 pt Sevin	3 oz Fruitone-N plus 1 pt Sevin	
Quinte		5.5 oz Amide Thin plus 1 pt Sevin		
R.I. Greening			3 oz Fruitone-N plus 1 pt Sevin	

Table 11.6.2. Recommendations for thinning specific apple varieties in New England.

The chemicals and rates suggested in this table are the "best suggestion" of the authors for mature trees with a heavy fruit set and "normal" fruit thinning weather. Our rates should be adjusted up or down by 50% depending on weather conditions, pollination, fruit set and tree sensitivity. Other chemicals, rates, timings and combinations may also work.

	APPLICATION TIMING			
	50% Full Bloom	Petal Fall (1 week after bloom)	8-14 mm fruit size (2-3 weeks after bloom)	Return Bloom Enhancer (4-6 weeks after bloom)
VARIETY	*Rates are per 100 gallons based on a full dilute TRV application**			
Rome Beauty (Non Spur)			2 oz Fruitone-N plus 1 pt Sevin	
Rome Beauty (Spur)		2 oz Fruitone-N plus 1 pt Sevin	3 oz Fruitone-N plus 1 pt Sevin **OR** 64 oz 6-BA plus 1 pt Sevin	
Spartan and Acey Mac		2 oz Fruitone-N plus 1 pt Sevin	3 oz Fruitone-N plus 1 pt Sevin **OR** 64 oz 6-BA plus 1 pt Sevin	
Stayman			2 oz Fruitone-N plus 1 pt Sevin	
Tydeman			2 oz Fruitone-N plus 1 pt Sevin	
Vista Bella			2 oz Fruitone-N plus 1 pt Sevin	
Wealthy			3 oz Fruitone-N plus 1 pt Sevin	
Yellow Newtown			3 oz Fruitone-N plus 1 pt Sevin	
Yellow Transparent		5.5 oz AmideThin plus 1 pt Sevin		

*To convert to alternative formulations of NAA use tables11.6.3-11.6.7. All rates are amounts per 100 gal assuming a full dilute tree row volume (TRV) spray. Rate per acre = amount/hundred gallons X hundreds of gallons per acre TRV dilute. Tree Row Volume dilute gallonage (TRV)= (Tree Height X Tree Width X 43560 X 0.7) / (Between Row Spacing X1000). The rate per acre may safely be concentrated 3X.

Table 11.6.3 Conversion of ppm Maxcel or RiteWay BA thinners to fluid ounces for various TRV gallonages.

Dilute	PPM Maxcel					
Gallonage	25	50	75	100	125	150
per Acre	Fluid ounces per acre[1]					
50	8	16	24	32	40	48
100	16	32	48	64	80	96
150	24	48	72	96	120	144
200	32	64	96	128	160	192
250	40	80	120	160	200	240
300	48	96	144	192	240	288
350	56	112	168	224	280	
400	64	128	192	256		

[1]To convert fluid ounces to milliliters, multiply fluid ounces by 29.57.

Table 11.6.4. Conversion of ppm Exilis Plus to fluid ounces for various TRV gallonages.

Dilute	PPM Maxcel					
Gallonage	25	50	75	100	125	150
per Acre	Fluid ounces per acre[1]					
50	7.5	15	22.5	30	37.5	45
100	15	30	45	60	75	90
150	22.5	45	67.5	90	112.5	135
200	30	60	90	120	150	180
250	37.5	75	112.5	150	187.5	225
300	45	90	135	180	225	270
350	52.5	105	157.5	210	262.5	
400	60	150	180	240		

1To convert fluid ounces to milliliters, multiply fluid ounces by 29.57.

Table 11.6.5. Conversion of ppm Fruitone N to ounces (lb.) for various dilute TRV gallonages.

Dilute	PPM Fruittone N				
Gallonage	2.5	5	7.5	10	12.5
per Acre	Ounces (lb.) per acre*				
50	0.5	1	1.5	2	2.5
100	1	2	3	4	5
150	1.5	3	4.5	6	7.5
200	2	4	6	8	10
250	2.5	5	7.5	10	12.5
300	3	6	9	12	15
350	3.5	7	10.5	14	17.5
400	4	8	12	16	20

*To convert ounces (lb) to grams, multiply fluid ounces by 28.3.

Table 11.6.6. Conversion of ppm of Amide-Thin W to ounces (lb.) for various dilute TRV gallonages.

Dilute	PPM Amide-Thin W				
Gallonage	10	20	30	40	50
per Acre	Ounces (lb.) per acre*				
50	0.8	1.6	2.4	3.2	4
100	1.6	3.2	4.8	6.4	8
150	2.4	4.8	7.2	9.6	12
200	3.2	6.4	9.6	12.8	16
250	4	8	12	16	20
300	4.8	9.6	14.4	19.2	24
350	5.6	11.2	16.8	22.4	28
400	6.4	12.8	19.2	25.6	32

* To convert ounces (lb) to grams multiply, ounces by 28.3.

Table 11.6.7. Conversion of ppm of Ethrel to fluid ounces for various dilute TRV gallonages.

Dilute	PPM Ethrel			
Gallonage	150	300	450	600
per Acre	Fluid ounces per acre*			
50	4	8	12	16
100	8	16	24	32
150	12	24	36	48
200	16	32	48	64
250	20	40	60	80
300	24	48	72	96
350	28	56	84	112
400	32	64	96	128

*To convert fluid ounces to milliliters, multiply fluid ounces by 29.57.

Table 11.6.8. Conversion of lb. a.i. of Sevin XLR Plus or Sevin 4F to fluid ounces for various dilute TRV gallonages.

Dilute	lb. ai. of Sevin XLR Plus or Sevin 4F			
Gallonage	0.25	0.5	0.75	1.0
per Acre	Fluid ounces per acre*			
50	4	8	12	16
100	8	16	24	32
150	12	24	36	48
200	16	32	48	64
250	20	40	60	80
300	24	48	72	96
350	28	56	84	112
400	32	64	96	128

*To convert fluid ounces to milliliters, multiply fluid ounces by 29.57.

11.7 Other Growth Regulator Uses In Apples In New England

In addition to their use in chemical thinning, growth regulating chemicals are also used in apple production to modify tree growth and fruit development. Since growth regulating chemicals affect plant metabolism, good spray coverage and good uptake of the chemical are essential for proper response.

11.8 Growth Regulator Chemicals Registered in New England

Apogee (prohexadione-calcium) is a growth regulator that reduces vegetative growth by inhibiting the synthesis of gibberellins, which are naturally occurring plant hormones that control cell elongation. Growers can expect about a 40–50% reduction in terminal growth from Apogee.

Apogee also limits fire blight development in apple shoots but will not protect against blossom blight infection. Although Apogee has no pesticidal activity on the fire blight bacteria itself, it affects the development of the shoot blight by causing a cessation of shoot growth, which in turn makes the shoots less susceptible to fire blight development. In order to get the maximum benefit in growth reduction and fireblight protection, it is important to make the first application when shoots are 1–3 inches long. This means Apogee must be applied at or before petal fall to have a large effect on shoot growth. Later applications will be less effective at stopping shoot growth. The onset of shoot growth control and resistance against shoot fire blight infections develops 10 to 14 days after treatment. Thus, apple trees must be treated in a protective manner before shoot blight symptoms develop. After resistance is acquired, it should last from 4–6 weeks. To maintain fire blight protection, a second spray is required if shoots begin to grow again. A low dose provides growth controls for only about 3–4 weeks, while a high dose controls growth for 6–8 weeks. At least two applications will be required to achieve season-long growth control in most New England orchards.

Apogee-treated apple trees often set more fruit than untreated trees It may also be necessary to adjust thinning strategy to remove more fruit. This may mean using an increased dosage (30–50%) of a chemical thinner or multiple applications of chemical thinners to achieve desired crop load and fruit size.

Ethephon (Ethrel) is a growth regulator that stimulates ethylene production by the plant. It can be used to thin apple and improve flower bud development when used within a few weeks of bloom, and to improve fruit color and advance fruit maturation when used near harvest. Its use near harvest significantly reduces fruit storage life and shelf life, and can cause excessive fruit drop if fruits are not harvested within 10 days after application

Naphthaleneacetic acid (NAA) is an auxin-type growth regulator that can induce fruit thinning early in the season and reduce fruit drop late in the season. At very high rates, it can stop the development of watersprouts and rootsuckers. Its use as a chemical thinner is described in the thinning section. Its primary use as a growth regulator is to reduce preharvest drop. When it is used to reduce drop, it does not delay ripening, which may result in overripe fruit that have a shorter storage life if harvest is delayed. The level of drop control depends on rate, with 20 ppm giving better control than 10 ppm; however, the higher rate also advances ripening and may shorten fruit storage life.

The use of NAA to control watersprouts and rootsucker is with a formulation that is more active (Tre-Hold) and at rates 1,000 times that of its use as a chemical thinner or for drop control. The Tre-Hold formulation must never be used for thinning or drop control.

BA/GA (Promalin, Perlan, Ritesize or Typy) are growth regulators containing a combination of equal parts of benzyl adenine (a cytokinin) and GA 4+7 (gibberellins). They are used to stimulate growth of fruits and/or lateral branches. Their primary effect on fruit growth is to increase the length:width ratio (typiness) of the fruit. Their primary use is with Delicious, where typiness can be an important marketing advantage. They have their best effect on typiness in a narrow timing window when king blooms are open. At later timings and at high rates, they can cause fruit thinning. The best response is obtained when temperatures are warm (>70° F) and the spray is applied as a fine mist in 50–100 gallons of water.

BA/GA is also used to induce lateral branching of nursery trees and young orchard trees, but at rates of 5–10 times those used to increase typiness. Applications are made on nursery trees when the tree is 26–32” high (mid-June), while on orchard trees, applications are made earlier, when shoots are 1–2” long (near bloom). BA/GA can also be applied at bud break by painting or spraying it on the swollen buds.

GA 4+7 (Provide, Novagib) are commercial formulations of gibberellins A4+7. They are used on apples to reronduce fruit russeting. Russeting is associated with high humidity early in the season and certain strains of yeast. Certain fungicides such as captan and polyram reduce russeting by controlling these strains of yeast, but it is unclear how GA 4+7 reduces russeting. The use of several early season sprays of GA 4+7 beginning at petal fall have been shown to be effective. The most susceptible varieties to russeting are: Golden Delicious, Fuji, Rome, Cortland, Idared, Crispin and Jonagold. The use of GA 4+7 may interact with the use of other growth regulators such as Apogee, since GA 4+7 is a gibberellin and Apogee inhibits synthesis of gibberelins.

ReTain is a commercial formulation of aminoethoxy-vinylglycine (AVG). It is used to reduce preharvest drop and to delay harvest. It acts by inhibiting the synthesis of ethylene in the plant. Since ethylene production by the fruit increases dramatically as fruits ripen, ReTain must be applied before fruits are mature to hold ethylene production in check. The label suggests 3-4 weeks before normal harvest. Application of ReTain 2 weeks before anticipated harvest has the advantage of extending drop control later into the season. Application at this timing is permitted as long as the preharvest interval is 3 weeks. It requires 10 to 14 days for ReTain to initiate drop control, so there is the possibility of some drop occurring before drop control can be initiated. ReTain will generally delay harvest and fruit drop by 7–10 days, thus giving growers flexibility with harvest date. ReTain also delays other aspects of fruit ripening such as color development, starch degradation and firmness loss, but if harvest is delayed 7–10 days, ReTain-treated fruits achieve normal color and maturity.

Table 11.8.1. Growth regulator uses in apples.

Timing	Product	Concentration	Rate of Formulated Product
CONTROL OF WATERSPROUTS AROUND PRUNING CUTS			
Dormant	Tre-Hold A112	10,000 ppm	10 fl oz/1 gal
	Tre-Hold RTU (NAA)	1.5% (15,000 ppm) (Do not dilute)	Ready-to-use product
Mix NAA with 2 pt latex paint/gal and apply any time after dormant pruning but before growth begins in spring. Apply with paint brush or cloth pad to thoroughly coat exposed wood and edges of bark around pruning cuts.			
CONTROL OF ROOTSUCKERS			
Dormant or 6-12" Sucker height	Tre-Hold A112	10,000 ppm	8 gal/100 gal
	Tre-Hold RTU (NAA)	1.5% (15,000 ppm) (Do not dilute)	Ready-to-use product
Apply during dormant season after pruning existing suckers and before resprouting, or apply when new sprouts are 6 –12" high. Thorough wetting of stubs or new sprouts is essential.			
IMPROVE SHAPE (TYPINESS) OF DELICIOUS APPLE FRUITS			
Early King Bloom to 50% Bloom	Promalin, Perlan, Typy	25-50 ppm	1-2 pt/100 gal
Apply as a fine mist using 50–100 gallons/acre. Do not apply more than 2 pt/acre. Fruit thinning may occur at high rates. Use of a surfactant increases both typiness and thinning responses.			
INDUCTION OF LATERAL BRANCHING IN YOUNG TREES			
1-2" of Terminal Shoot Growth	Promalin	125-500 ppm	0.25-1 pt/5 gal
Include a non-ionic surfactant and apply as a directed spray to areas where additional branching is desired. This practice is more effective in the second and third growing seasons after planting. Response on weak or low-vigor trees is usually disappointing.			
VEGETATIVE GROWTH CONTROL / FIRE BLIGHT SUPPRESSION			
1-3 inches of new growth (Late bloom-early petal fall	Apogee	62.5-250 ppm	2.75-9 oz (lb)*/100 gal

The first application should be made as soon as shoot growth begins with a second spray 2-3 weeks after the first. In some cases a third application may be required. Do not apply Apogee within 10 days of chemical thinners. Do not apply more than 48 ounces of Apogee per acre within any 21-day interval, and a max of 99 oz of Apogee per acre per season. Always use a surfactant and a water conditioner such as ammonium sulfate, Choice or Quest (these products control "hard water" deactivation of Apogee). Do not tank-mix with sprays containing calcium. Use of Apogee may necessitate use of increased chemical thinning to achieve desired crop load. Apogee must be applied well in advance of the appearance of fire blight symptoms to be effective for fire blight suppression. To control vigor in only the top of the tree, directed sprays to the top of the tree.

Timing	Product	Concentration Product	Rate of Formulated Product
INDUCTION OF LATERAL BRANCHING IN NURSERY TREES			
When Terminal Shoot is 26-32" long	Promalin	125-500 ppm	0.25-1 pt/5 gal

Include a non-ionic surfactant and apply as a directed spray to areas where additional branching is desired when terminal shoot is at the height where branches are desired.

SUPPRESSION OF "PHYSIOLOGICAL" FRUIT RUSSETING			
Petal Fall	Pro-Vide 2% Liquid	15-20 ppm	10-13 fl oz/acre
	Pro-Vide 10 SG	15-25ppm	60-100 g/acre

Apply 2-4 applications beginning at petal fall and continuing at 7-10 day intervals. Spray at 100 gallons per acre. Max of 40 oz of ProVide per season. Do not use a surfactant when applying Pro-Vide.

REDUCE CRACKING OF STAYMEN APPLES			
July	Pro-Vide	25-50 ppm	8-16 fl oz/100 gal

Apply 3-6 applications every 14-21 days beginning 2-3 weeks before fruit cracking is likely. If used to reduce russetting, it may not be used for cracking control.

INCREASED FLOWER BUD DEVELOPMENT			
NON BEARING TREES	Ethrel	300-450 ppm	1-1.5 pt/100 gal
2-4 weeks after full bloom			
BEARING TREES			
4-6 weeks after full bloom	Ethrel or	150 ppm	1-1.5 pt/100 gal
	NAA	5ppm	2 oz (lb)*/100gal

Spray trees with enough water to uniformly cover the canopy. Apply 3-4 weekly applications. Avoid use of Ethrel on Macoun, Honeycrisp and McIntosh due to advanced ripening.

PREHARVEST FRUIT-DROP CONTROL			
3-4 weeks before anticipated harvest	Re-Tain	130 ppm	0.74 lb/acre or 333g/acre or 1 pouch

Apply in sufficient water to ensure thorough but not excessive coverage. For mature trees, this should be 100 gal/acre. An organosilicone surfactant (12 oz/100 gal) should be used with ReTain. In hot years apply Retain at least 4 weeks before harvest. In cooler years apply ReTain 3 weeks before anticipated harvest. Application 2 weeks before anticipated normal harvest is an option where drop control is desired for an extended period of time.

Drop of first Sound Fruit	Fruitone N	10-20 ppm	4-8 oz (lb)* / 100 gal

Varieties such as McIntosh which are highly prone to preharvest drop require careful monitoring to determine when fruit drop is beginning. Limb-tapping should be used to help determine the onset of drop as fruit near maturity. Approximate duration of drop control varies with dosage: 10 ppm = 6 days; 20 ppm = 10 days. Do not make more than 2 applications. High rates of NAA advance fruit maturity and may shorten fruit storage life.

PROMOTE FRUIT COLORING, PROMOTE UNIFORM RIPENING, ADVANCE FRUIT MATURATION			
2-3 weeks before normal harvest	Ethrel	75-300 ppm	0.25-1 pt / 100 gal

If fruit is to placed in CA storage then harvest should be done 7 days after application. If fruit is to be left on the tree longer than 7 days after application of Ethrel then apply NAA at 10-20 ppm 3 days after Ethrel application to help control preharvest drop. Ethrel will cause excessive fruit preharvest drop about 10 days after application if NAA is not used. Any delay in harvest or cooling of fruit treated with Ethrel will result in unacceptable softening and short storage life.

*To convert ounces (lb) to grams, multiply ounces by 28.3. To convert fluid ounces to milliliters, multiply fluid ounces by 29.57.

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