



**A Profile of
Commercial Apple
Production in
Kentucky
2017**

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AUTHORS

Nicole Ward Gauthier

Extension Assistant Professor
Department of Plant Pathology

Kimberly Leonberger

Extension Associate
Department of Plant Pathology

Ricardo Bessin

Extension Professor
Department of Entomology

Matthew Springer

Extension Assistant Professor
Department of Forestry

John Strang

Extension Professor
Department of Horticulture

Shawn Wright

Extension Associate Professor
Department of Horticulture

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Cover Photo

Bitter Rot of Apple, Nicole Ward Gauthier, University of Kentucky

Trade names are used to simplify information in this publication. No endorsement is intended nor is criticism implied of similar products that are not named. This guide is for reference only; the most recent product label is the final authority concerning application rates, precautions, harvest intervals, and other relevant information.

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Introduction

KENTUCKY APPLE PRODUCTION FACTS

- Kentucky has a total of 554 farms (U.S. rank: 13th) and 962 acres (U.S. rank: 30th) in apple production.
 - Apple production in Kentucky represents 2% of total Kentucky farms and 0.25% of total apple acreage in the U.S.
 - Approximately 25 growers account for the majority of Kentucky's apple production.
 - Orchard size ranges from less than 1 acre to just over 40 acres.
 - Growers report that 50% to 90% of apples are sold on-site or at farmers markets. They are primarily sold at retail prices. Some apples are sold to schools at retail prices. The remaining apples are sold wholesale to retailers. Few apples produced in Kentucky are sold outside of the state.
 - Average apple market prices range from \$0.71 to \$2.40 per pound (average \$1.34) for retail markets and from \$0.39 to \$1.19 per pound (average \$0.73) for wholesale markets.
- Average apple yield varies from 450,000 to 750,000 bushels per year.
 - Cash value of Kentucky apple production is valued at \$24.4 million to \$40.6 million per year.
 - Annual production costs vary by orchard size, but growers report production costs at approximately \$10 per bushel.
 - The table below represents the most widely cultivated apple varieties in Kentucky.

Apple Variety	Percent of State Production Acreage
Golden Delicious	14%
Gala	10%
Honeycrisp	8%
Fuji	7%
Gold Rush	5%
Winesap	5%



Nicole Ward Gauthier, University of Kentucky



Steve Patton, University of Kentucky

PRODUCTION AREAS

Apple production in Kentucky boasts a unique market; it is small, yet profitable. Orchards are widely distributed across the state, and no co-ops or apple grower marketing associations exist. This structure results in limited information exchange, buying power for supplies, or large-scale sales/marketing. As a result, the majority of Kentucky apples are sold on-site or at local farmers markets.

Most orchards also include other tree fruit, small fruit, and/or specialty produce. According to the 2012 U.S. Census of Agriculture, 1.4% or 1,113 farms in Kentucky produced fruit, tree nuts and/or berries. The total market value of these commodities was \$7.8 million, approximately 0.2% of sales of all agriculture products in Kentucky. This is a dramatic increase from 2007 census data, which reported that 713 farms were producing fruits, tree nuts, and/or berries for a total of \$3 million in value.

Determining the value of Kentucky apple production has proven to be challenging as a result of these mixed orchard systems. However, the estimated gross value of Kentucky apple production is \$24.4 million to \$40.6 million.

The value of produce has expanded steadily over the past 10 years and is driven by growth in local

sales. More producers are selling through direct, higher-value channels driven in part by a local foods emphasis.

Many Kentucky apple growers have established operations that offer additional entertainment options such as playgrounds, live music, festivals, school tours, and corn mazes. These agritourism venues contribute approximately \$10 billion per year to Kentucky's tourism industry. This multifaceted approach provides buffers to business risks, but also complicates crop production and management of disease and pest issues. With limited time to attend to all aspects of business, some growers have admitted to forsaking pest management for other tasks or priorities. The numerous types of crops produced within a single operation means that growers must have a wide range of knowledge of production practices, cultivar selection, and disease and pest identification and management.

Production of multiple types of fruit within an operation can add additional disease and insect pressure. Many diseases and insects are capable of infecting/infesting several types of fruits, creating a "green bridge" from one crop to the next. Yield loss risk can increase as a result of mixed plantings. In addition, growers must recognize and manage disease and insect issues to reduce more significant losses.

PRODUCTION PRACTICES & PEST MANAGEMENT

Kentucky's locale is uniquely located in the southernmost sector of the eastern apple-producing region. Cultivars are primarily "Midwest varieties," which provide cold tolerance and limited amounts of disease resistance. However, factors such as length of growing seasons can vary widely between the Midwestern states and Kentucky. Growers in Kentucky face greater risk for spring frost/freeze damage due to early bloom, as well as increased labor for managing high plant vigor.

During the past 10 years, orchard practices have changed dramatically. Many of these practices contributed to conditions conducive for diseases and pests. Growers began to shift from traditional plant spacing to high density plantings, increasing tree stress and humid microclimates conducive for diseases. Smaller trees, however, reduce pruning labor and enable better spray coverage as compared with larger trees. Cultivar selection has changed with consumer demand, and with each shift in cultivar comes new challenges, such as increased disease susceptibility. Additionally, new and emerging pests/diseases present different challenges, while many pesticides and fungicides have been discontinued and new ones have entered the market.

Innovative new tools and technologies have been adopted by some of the more progressive growers, thus reducing inputs and resulting in more precise pesticide applications. For example, pheromone traps combined with trapping data can help growers identify thresholds before insecticide applications. During the past 4 years, the University of Kentucky Fruit IPM Working Group has updated and streamlined the UK AgWeather Plant Disease and Insect Prediction Model site to assist grower decision-making. Growers also have access to university-produced printed publications, virtual information, and social media sites.

Major research and recommendations produced by universities in the top fruit-producing states may be unsuitable or inappropriate for Kentucky's climate or geographically induced pest/disease pressure. Some of the information produced in the Midwest or Atlantic regions can be valuable to Kentucky programs. However, in other cases, Kentucky orchard sizes and practices, cultivar selections, adaptability of those cultivars, as well as unique climatic conditions, contrast with those of other regions. Thus, the University of Kentucky Fruit IPM Working Group has developed specific recommendations and practices that are suitable for these unique conditions.

Variations in farm size, grower practices, crop selection, business models, and available resources result in a variety of farm types across the Commonwealth. A recent survey of growers indicated that actual on-farm practices varied greatly from grower to grower and from those recommended by University of Kentucky State Extension Specialists. Chapter 2 compares grower practices to University of Kentucky pest management recommendations.



John Hartman, University of Kentucky

Production Practices

The following table compares grower practices (as indicated in a 2016 grower survey) to University of Kentucky pest management recommendations. This table highlights both successes and failures in these practice and accentuates areas for further training and resource development.

COMPARISON OF UK COMMERCIAL APPLE PRODUCTION RECOMMENDATIONS AND ACTUAL KENTUCKY GROWER PRACTICES.

Apple Growth Stage	University of Kentucky Recommendation	Grower Practices*	Comments
Dormant	<p><u>Cultural</u></p> <ul style="list-style-type: none"> • Prune. • Remove prunings from orchard. <p><u>Diseases</u></p> <ul style="list-style-type: none"> • Remove mummies from trees. <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Spray pre-emergent broadleaf herbicides as early as possible in spring. Some products must be applied during late spring/dormancy. <p><u>Wildlife</u></p> <ul style="list-style-type: none"> • Check wildlife exclosures for areas that may require repairs. 	<p><u>Cultural</u></p> <ul style="list-style-type: none"> • Apply calcium. • Prune. <p><u>Diseases</u></p> <ul style="list-style-type: none"> • Apply nitrogen. • Spray copper and oil. • Flail mow. • Monitor weather. <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Spray herbicides. 	<p><u>Cultural</u></p> <ul style="list-style-type: none"> • Apply lime if soil pH is low. <p><u>Diseases</u></p> <ul style="list-style-type: none"> • Most growers did not indicate a focus on sanitation. It is unclear whether growers have a solid understanding of sanitation. • Scab is not a severe threat to Kentucky apple orchards, therefore, flail mowing and nitrogen applications are not highly-ranked recommendations.
Silver Tip	<p><u>Diseases & Insects</u></p> <ul style="list-style-type: none"> • Apply copper for suppression of the fire blight pathogen and oil for suppression of scale and mites. <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Spray pre-emergent herbicides if they were not applied during dormancy. 	<p><u>Diseases</u></p> <ul style="list-style-type: none"> • Apply copper and oil. • Apply fungicides. • Apply nitrogen. • Monitor weather. • Utilize weather models. <p><u>Insects</u></p> <ul style="list-style-type: none"> • Scout. <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Mow. • Spray herbicides. 	<p><u>Diseases</u></p> <ul style="list-style-type: none"> • Scab is not a severe threat to Kentucky apple orchards, therefore' flail mowing and nitrogen applications are not highly-ranked recommendations. • Fungicides are not recommended during dormancy. • Copper is used as a bactericide. <p><u>Diseases & Insects</u></p> <ul style="list-style-type: none"> • Weather models are not beneficial until flowering (fire blight) and growing season (fungal diseases and insects).

*Grower practices as described by Kentucky growers in 2016 survey.

COMPARISON OF UK COMMERCIAL APPLE PRODUCTION RECOMMENDATIONS AND ACTUAL KENTUCKY GROWER PRACTICES.

Apple Growth Stage	University of Kentucky Recommendation	Grower Practices*	Comments
Green Tip	<p><u>Diseases</u></p> <ul style="list-style-type: none"> Scab is not a major disease in Kentucky, but orchards with a history of disease should focus on primary scab infections. <p><u>Insects</u></p> <ul style="list-style-type: none"> Management of aphids, scale insects, and mites. <p><u>Weeds</u></p> <ul style="list-style-type: none"> Spray pre-emergent herbicides if they were not applied during dormancy or silvertip. 	<p><u>Cultural</u></p> <ul style="list-style-type: none"> Apply calcium. <p><u>Diseases</u></p> <ul style="list-style-type: none"> Apply nitrogen. Spray copper. Spray copper and oil. Spray fungicide. Monitor weather; utilize weather models. <p><u>Insects</u></p> <ul style="list-style-type: none"> Install pheromone traps. Scout. <p><u>Weeds</u></p> <ul style="list-style-type: none"> Mow. Spray herbicide. 	<p><u>Cultural</u></p> <ul style="list-style-type: none"> Apply nitrogen fertilizer based on previous season's tree growth. This is too early to apply calcium chloride sprays because these sprays are intended to move calcium in through skin of fruit; there are no fruit on trees during green tip. <p><u>Diseases</u></p> <ul style="list-style-type: none"> Do not apply copper after ¼-inch green. Scab is not a severe threat to Kentucky apple orchards, therefore, flail mowing and nitrogen applications are not highly-ranked recommendations. Fungicide applications at this early stage are effective against scab, only. Weather models for disease are not beneficial until flowering (fire blight) and growing season (fungal diseases). <p><u>Insects</u></p> <ul style="list-style-type: none"> Delaying oil application until ½-inch green will control mites better than earlier applications. Weather models for insects are not beneficial until the growing season.
Half-Inch Green	<p><u>Disease</u></p> <ul style="list-style-type: none"> Scab is not a major disease in Kentucky, but orchards with a history of disease should focus on primary scab infections. <p><u>Insect</u></p> <ul style="list-style-type: none"> Manage scale and aphids. <p><u>Weeds</u></p> <ul style="list-style-type: none"> Spray post-emergent broadleaf weed management throughout the season, as appropriate. 	<p><u>Disease</u></p> <ul style="list-style-type: none"> Monitor weather; utilize weather models. Spray fungicides. <p><u>Insect</u></p> <ul style="list-style-type: none"> Spray oil. Scout. Hang traps (codling moth and oriental fruit moth). Spray insecticides. Monitor weather; utilize weather models <p><u>Weeds</u></p> <ul style="list-style-type: none"> Spray herbicides. Remove weeds. Mow. 	<p><u>Disease</u></p> <ul style="list-style-type: none"> Fungicide applications at this early stage are effective against scab, only. Do not apply copper after ¼-inch green. Weather models for diseases are not beneficial until flowering (fire blight) and growing season (fungal diseases). <p><u>Insects</u></p> <ul style="list-style-type: none"> Delaying oil application until ½-inch green will control mites better than earlier applications. Weather models for insects are not beneficial until the growing season.

*Grower practices as described by Kentucky growers in 2016 survey.

COMPARISON OF UK COMMERCIAL APPLE PRODUCTION RECOMMENDATIONS AND ACTUAL KENTUCKY GROWER PRACTICES.

Apple Growth Stage	University of Kentucky Recommendation	Grower Practices*	Comments
Tight Cluster	<p><u>Diseases</u></p> <ul style="list-style-type: none"> • Protect against scab, rust, and powdery mildew diseases. <p><u>Insect</u></p> <ul style="list-style-type: none"> • Manage scale and aphids. 	<p><u>Diseases</u></p> <ul style="list-style-type: none"> • Monitor weather; utilize weather models. • Spray fungicides. • Integrated Pest Management (IPM). <p><u>Insects</u></p> <ul style="list-style-type: none"> • Scout. • Spray insecticides for aphids and scale. • Monitor traps. • Integrated Pest Management (IPM). • Monitor weather; utilize weather models. <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Spray herbicides. • Remove weeds; mow. 	<p><u>Note</u></p> <ul style="list-style-type: none"> • Several growers indicated use of Integrated Pest Management (IPM), but there were no specific actions associated with this. It is unclear whether growers have a solid understanding of IPM. <p><u>Diseases</u></p> <ul style="list-style-type: none"> • Weather models for diseases are not beneficial until flowering (fire blight) and growing season (fungal diseases). • Critical time for management of rust. <p><u>Insects</u></p> <ul style="list-style-type: none"> • Weather models for insects are not beneficial until growing season. <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Pre-emergent herbicides should be applied early before weeds create a barrier to-ground contact. • Broadleaf weeds should be managed before bloom to prevent competition for pollinating insects.
Pink	<p><u>Cultural</u></p> <ul style="list-style-type: none"> • Apply foliar boron • Apply foliar urea if tree vigor is low. <p><u>Diseases</u></p> <ul style="list-style-type: none"> • Protect against scab, rust, and powdery mildew diseases. <p><u>Insect</u></p> <ul style="list-style-type: none"> • Manage aphids and plant/stink bugs. • Monitor codling moth and Oriental fruit moth populations using pheromone traps in orchard. <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Spray post-emergent herbicides before bloom to eliminate competing blooms that may compete for pollinators. 	<p><u>Cultural</u></p> <ul style="list-style-type: none"> • Apply boron. <p><u>Diseases</u></p> <ul style="list-style-type: none"> • Spray fungicide. • Monitor weather; utilize weather models. • Integrated Pest Management (IPM). <p><u>Insects</u></p> <ul style="list-style-type: none"> • Spray insecticide. • Monitor weather; utilize weather models. • Integrated Pest Management (IPM). • Monitor traps. <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Spray herbicides. • Scout. • Integrated Pest Management (IPM). • Remove weeds; mow. 	<p><u>Note</u></p> <ul style="list-style-type: none"> • Several growers indicated use of Integrated Pest Management (IPM), but there were no specific actions associated with this. It is unclear whether growers have a solid understanding of IPM. <p><u>Diseases</u></p> <ul style="list-style-type: none"> • Monitor blossoms so that fire blight management sprays can begin at the first sign of open blossoms. • Monitor weather models in preparation for bloom.

*Grower practices as described by Kentucky growers in 2016 survey.

COMPARISON OF UK COMMERCIAL APPLE PRODUCTION RECOMMENDATIONS AND ACTUAL KENTUCKY GROWER PRACTICES.

Apple Growth Stage	University of Kentucky Recommendation	Grower Practices*	Comments
<p>Bloom</p>	<p><u>Diseases</u></p> <ul style="list-style-type: none"> • Protect from fire blight beginning at first sign of open blooms until petal fall. Use weather prediction models to monitor risk. • Apply growth regulators to vigorous, particularly fire blight-susceptible trees in efforts to slow growth and protect from fire blight (shoot blight). • Protect against scab, rust, and powdery mildew. <p><u>Insects</u></p> <ul style="list-style-type: none"> • Use pheromone traps to monitor codling moths. • Save the bees. Do not use insecticides or miticides during bloom. 	<p><u>Diseases</u></p> <ul style="list-style-type: none"> • Spray bactericides. • Apply growth regulator. • Spray fungicides. • Monitor weather; utilize weather models. • Integrated Pest Management (IPM). <p><u>Insects</u></p> <ul style="list-style-type: none"> • Monitor traps. • Monitor weather; utilize weather models. • Scout. • Integrated Pest Management (IPM). <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Remove weeds; mow. 	<p><u>Note</u></p> <ul style="list-style-type: none"> • Several growers indicated use of Integrated Pest Management (IPM), but there were no specific actions associated with this. It is unclear whether growers have a solid understanding of IPM. <p><u>Diseases</u></p> <ul style="list-style-type: none"> • Bloom is the most critical time for fire blight management. <p><u>Insects</u></p> <ul style="list-style-type: none"> • Save the bees. Do not use insecticides during bloom. • Codling moth traps are set out during bloom, but first catches are usually as late as petal fall or first cover.
<p>Petal Fall</p>	<p><u>Diseases</u></p> <ul style="list-style-type: none"> • Protect against scab, rust, and powdery mildew diseases. <p><u>Insects</u></p> <ul style="list-style-type: none"> • Manage plum curculio and aphids. <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Mow, as needed. 	<p><u>Cultural</u></p> <ul style="list-style-type: none"> • Apply nutrients. • Apply thinning spray. <p><u>Diseases</u></p> <ul style="list-style-type: none"> • Spray fungicides. • Monitor weather; utilize weather models. • Integrated Pest Management (IPM). <p><u>Insects</u></p> <ul style="list-style-type: none"> • Spray insecticides (plum curculio). • Scout. • Monitor traps. • Integrated Pest Management (IPM). • Monitor weather; utilize weather models. <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Mow. 	<p><u>Note</u></p> <ul style="list-style-type: none"> • Several growers indicated use of Integrated Pest Management (IPM), but there were no specific actions associated with this. It is unclear whether growers have a solid understanding of IPM.

*Grower practices as described by Kentucky growers in 2016 survey.

COMPARISON OF UK COMMERCIAL APPLE PRODUCTION RECOMMENDATIONS AND ACTUAL KENTUCKY GROWER PRACTICES.

Apple Growth Stage	University of Kentucky Recommendation	Grower Practices*	Comments
<p>First Cover</p>	<p>Cultural</p> <ul style="list-style-type: none"> • Apply calcium chloride for cork spot, bitter pit, and Jonathan spot. • Apply thinning spray. <p>Diseases</p> <ul style="list-style-type: none"> • Protect against fruit rot fungi (bitter rot, black rot, white rot) and sooty blotch/fly speck. <p>Insects</p> <ul style="list-style-type: none"> • Manage plum curculio, oriental fruit moth, codling moth, and aphids. <p>Weeds</p> <ul style="list-style-type: none"> • Spray post-emergent herbicides, as needed. • Mow, as needed. 	<p>Cultural</p> <ul style="list-style-type: none"> • Spray calcium. • Apply thinning spray. <p>Diseases</p> <ul style="list-style-type: none"> • Spray fungicides. • Integrated Pest Management (IPM). • Monitor weather; utilize weather models. <p>Insects</p> <ul style="list-style-type: none"> • Spray insecticides for plum curculio and codling moth. • Scout. • Monitor traps. • Integrated Pest Management (IPM). • Monitor weather; utilize <p>Weeds</p> <ul style="list-style-type: none"> • Spray herbicides. • Mow • Pull water sprouts 	<p>Notes</p> <ul style="list-style-type: none"> • Several growers indicated use of Integrated Pest Management (IPM), but there were no specific actions associated with this. It is unclear whether growers have a solid understanding of IPM. • Survey results contain several mentions of “spray fungicides” or “spray insecticides” when questions referred to target pests or specific products. It appears that many respondents may not be clear on timing of applications or group of products recommended. <p>Cultural</p> <ul style="list-style-type: none"> • Several thinning sprays may be required to achieve the desired amount of fruit thinning. <p>Diseases</p> <ul style="list-style-type: none"> • Management of fruit rots begins early in the season, preferably at petal fall (warm season), but at least at first cover. <p>Weeds</p> <ul style="list-style-type: none"> • Water sprouts may be pulled by hand to improve light/sun and spray penetration and to improve drying of foliage.

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COMPARISON OF UK COMMERCIAL APPLE PRODUCTION RECOMMENDATIONS AND ACTUAL KENTUCKY GROWER PRACTICES.

Apple Growth Stage	University of Kentucky Recommendation	Grower Practices*	Comments
<p>Second Cover</p>	<p><u>Diseases</u></p> <ul style="list-style-type: none"> • Protect against fruit rot fungi (bitter rot, black rot, white rot) and sooty blotch/fly speck. <p><u>Insects</u></p> <ul style="list-style-type: none"> • Manage oriental fruit moth and codling moth. <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Spray post-emergent herbicides, as needed. • Mow, as needed. <p><u>Wildlife</u></p> <ul style="list-style-type: none"> • Check wildlife exclosures for areas that may require repairs. 	<p><u>Cultural</u></p> <ul style="list-style-type: none"> • Apply calcium. <p><u>Diseases</u></p> <ul style="list-style-type: none"> • Spray fungicides. • Integrated Pest Management (IPM). • Monitor weather; utilize weather models. <p><u>Insects</u></p> <ul style="list-style-type: none"> • Spray insecticides. • Scout. • Monitor traps. • Integrated Pest Management (IPM). • Monitor weather; utilize weather models. <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Mow. • Pull water sprouts. • Spray herbicides. 	<p><u>Note</u></p> <ul style="list-style-type: none"> • Several growers indicated use of Integrated Pest Management (IPM), but there were no specific actions associated with this. It is unclear whether growers have a solid understanding of IPM. <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Crown suckers should be removed prior to application of glyphosate herbicide.
<p>Third Cover</p>	<p><u>Diseases</u></p> <ul style="list-style-type: none"> • Protect against fruit rot fungi (bitter rot, black rot, white rot) and sooty blotch/fly speck. <p><u>Insects</u></p> <ul style="list-style-type: none"> • Manage oriental fruit moth and codling moth. • Monitor apple maggot flies and apply insecticides if threshold is reached. <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Spray post-emergent herbicides, as needed. • Mow, as needed. 	<p><u>Cultural</u></p> <ul style="list-style-type: none"> • Begin harvest. • Spray calcium. • Inspect thinning. <p><u>Diseases</u></p> <ul style="list-style-type: none"> • Spray fungicides. • Integrated Pest Management (IPM). <p><u>Insects</u></p> <ul style="list-style-type: none"> • Scout. • Monitor weather; utilize weather models. • Monitor traps. • Spray insecticides. • Integrated Pest Management (IPM). <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Mow. • Spray herbicides. 	<p><u>Note</u></p> <ul style="list-style-type: none"> • Several growers indicated use of Integrated Pest Management (IPM), but there were no specific actions associated with this. It is unclear whether growers have a solid understanding of IPM. <p><u>Cultural</u></p> <ul style="list-style-type: none"> • Apply calcium chloride for cork spot, bitter pit, and Jonathan spot only if rain washed off the previous treatment.

*Grower practices as described by Kentucky growers in 2016 survey.

COMPARISON OF UK COMMERCIAL APPLE PRODUCTION RECOMMENDATIONS AND ACTUAL KENTUCKY GROWER PRACTICES.

Apple Growth Stage	University of Kentucky Recommendation	Grower Practices*	Comments
<p>Summer Cover Sprays</p>	<p><u>Cultural</u></p> <ul style="list-style-type: none"> • Collect tissue samples for nutrient analysis – between mid-July and mid-August. <p><u>Diseases</u></p> <ul style="list-style-type: none"> • Protect against fruit rot fungi (bitter rot, black rot, white rot) and sooty blotch/fly speck. <p><u>Insects</u></p> <ul style="list-style-type: none"> • Manage oriental fruit moth and codling moth. <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Spray post-emergent herbicides, as needed. • Mow, as needed. 	<p><u>Cultural</u></p> <ul style="list-style-type: none"> • Apply calcium. <p><u>Diseases</u></p> <ul style="list-style-type: none"> • Spray fungicides. • Integrated Pest Management (IPM). <p><u>Insects</u></p> <ul style="list-style-type: none"> • Scout. • Monitor weather; utilize weather models. • Monitor traps. • Spray insecticides. • Integrated Pest Management (IPM). <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Mow. • Spray herbicides. 	<p><u>Note</u></p> <ul style="list-style-type: none"> • Several growers indicated use of Integrated Pest Management (IPM), but there were no specific actions associated with this. It is unclear whether growers have a solid understanding of IPM.
<p>Pre-Harvest</p>	<p><u>Cultural</u></p> <ul style="list-style-type: none"> • Spray fruit stop-drop materials on varieties that tend to drop their fruit or if considerable harvest is required and there is not enough harvest labor. <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Mow, as needed. 		
<p>Post-Harvest</p>	<p><u>Cultural</u></p> <ul style="list-style-type: none"> • Prune in late winter (beginning in February). <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Optional: Spray a late autumn pre-emergence herbicide if time conflicts in spring make a pre-emergent application difficult. Fewer pre-emergence products are available for this application period. If pre-emergent herbicides are applied in fall, avoid disturbance of soil to retain protective barrier. <p><u>Wildlife</u></p> <ul style="list-style-type: none"> • Check wildlife enclosures for areas that may require repairs. • Apply bait for vole control in late-October. 	<p><u>Cultural</u></p> <ul style="list-style-type: none"> • Clean trees. • Prune. • Refrigerate produce. • Wash fruit. • Spray stop-drop and oil. <p><u>Insect</u></p> <ul style="list-style-type: none"> • Monitor traps. • Scout. • Integrated Pest Management (IPM). <p><u>Weeds</u></p> <ul style="list-style-type: none"> • Remove weeds; mow. 	<p><u>Note</u></p> <ul style="list-style-type: none"> • Several growers indicated use of Integrated Pest Management (IPM), but there were no specific actions associated with this. It is unclear whether growers have a solid understanding of IPM. <p><u>Cultural</u></p> <ul style="list-style-type: none"> • Oil is not required with stop-drop sprays. A low rate may be used for mite control.

*Grower practices as described by Kentucky growers in 2016 survey.

Bitter Rot

CATEGORY: Fungal disease

PATHOGENS: *Colletotrichum acutatum* spp. complex,
Colletotrichum gloeosporioides spp. complex

DAMAGE: Causes fruit to decay



Nicole Ward Gauthier, University of Kentucky

DESCRIPTION

Bitter rot lesions begin as small, sunken, localized areas on outer surfaces of fruit. As lesions mature, they remain sunken and circular, and red halos develop. During periods of rainy weather, salmon/pink spores appear in circular patterns. Under arid conditions, fungal fruiting structures (acervuli) are visible in lesions. Infected flesh develops cone-shaped rots that are brown and firm. Bitter rot infections are more severe during wet years. Symptoms begin to appear in early to mid-summer, but symptom development increases as fruit ripen and harvest approaches. Infection can occur as early as bloom.



IMPORTANCE

Major – Commercial growers ranked this disease as one of the most important in terms of yield loss, as well as one of the most difficult to manage. Disease severity varies with cultivar susceptibility and environmental conditions. Yield losses can range from 10% to 100%. Bitter rot is also common as a post-harvest and storage rot.

Bitter rot is more common in Kentucky than in states to the north or east. The disease is more prevalent in the central part of the state than in the mountainous Appalachian region or in the hotter western region.

MANAGEMENT

Critical Timing of Management Practices

Sanitation practices should be carried out throughout the entire the growing season to remove potential inoculum sources. Cultural practices are essential for fungicide efficacy. Infections can occur during bloom or shortly thereafter, especially if temperatures approach 80°F during bloom or petal fall.

Cultural Practices

- Remove infected fruit, fruit mummies, fallen infected fruit, and woody cankers and/or dead wood (sanitation).
- Consider disease susceptibility when selecting cultivars:
 - Least susceptible – Fuji, Ginger, Golden Delicious, Lodi, Pristine, Red Delicious, and Winesap.
 - Highly susceptible – Cripps Pink/Pink Lady, Enterprise, and Gold.
 - Extremely susceptible – Honeycrisp.
- Plan orchard spacing and orientation to provide air circulation and encourage rapid drying of morning dew or rain.
- Avoid excessive pruning and tree crowding to manage tree vigor.
- Chemically thin fruit in heavy cropping years.

Fungicides

Fungicide sprays begin at bloom or petal fall and continue until harvest. Currently there are no fungicide resistance issues reported for bitter rot. Fungicides containing captan may provide a moderate risk to pollinators. Limited research suggests that products containing mancozeb or ziram may also be toxic to pollinators if applied during bloom.

FUNGICIDES LABELED FOR MANAGEMENT OF BITTER ROT ON APPLE.

Fungicide	FRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Captan 80WDG, 4L, or 50WP (captan)	M	foliar/canopy spray	5 lbs. per acre	good to excellent	0 days	24 hours to 4 days	Most products have a REI of 24 hours, but some have 4 days. Moderate risk to pollinators.
Flint 50WG (trifloxystrobin)	11	foliar/canopy spray	2-2.25 oz. per acre	excellent	14 days	12 hours	Do not use with organosilicate surfactants. See note ³
Luna Sensation (fluopyram + trifloxystrobin)	7 + 11	foliar/canopy spray	4-5.8 fl. oz. per acre	good	14 days	12 hours	
Mancozeb 75DF (mancozeb)	M	foliar/canopy spray	3 lbs. per acre	excellent	77 days	24 hours	Do not apply more than 24 lbs. (prebloom applications)/21 lbs. (extended protectant program) per acre per year. May be toxic to pollinators. See note ³
Merivon (fluxapyroxad + pyraclostrobin)	7 + 11	foliar/canopy spray	4-5.5 fl. oz. per acre	good	0 days	12 hours	Do not apply with captan, EC, or oil-based products. See note ³
Pristine 38WG (pyraclostrobin + boscalid)	7 + 11	foliar/canopy spray	14.5-18.5 oz. per acre	good	0 days	12 hours	See note ³
Sovran 50WG (kresoxim-methyl)	11	foliar/canopy spray	4-6.4 oz. per acre	good	30 days	12 hours	See note ³
Ziram 76DF (ziram)	M	foliar/canopy spray	6 lbs. per acre	good	14 days	48 hours	Do not exceed 32.2 lbs. a.i. per acre or 7 applications per crop cycle. May be toxic to pollinators.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³ Note: Limited number of applications or other restrictions apply.

Biological Methods

Biofungicides are recent introductions to the mainstream commercial product market. Limited research is available regarding efficacy, although

performance is often minimal to moderate in comparison to synthetic fungicides. Cultural practices, especially sanitation, are essential for performance of these products.

BIOFUNGICIDES LABELED FOR MANAGEMENT OF BITTER ROT ON APPLE.

Biofungicide	Application Method	Rate	Comments
Actinovate AG (<i>Streptomyces lydicus</i> strain WYEC 108)	Foliar/canopy spray every 7 to 14 days	3-12 oz. per acre	OMRI listed. Use with spreader sticker. Limited research confirms that Actinovate AG is not effective when used alone, but it can provide minimal to moderate suppression of fruit rots when used in rotation with copper products.
Double Nickel 55 (<i>Bacillus amyloliquefaciens</i> strain D747)	Foliar/canopy spray every 7 to 10 days	0.25-3.0 lbs. per acre	OMRI listed. Limited research confirms that Double Nickel is not effective when used alone, but it can provide minimal to moderate suppression of fruit rots when used in rotation with copper products.
Serenade (QST 713 strain of <i>Bacillus subtilis</i>)	Foliar/canopy spray		OMRI listed. Various formulations are available (ASO, Max, Opti) at various concentrations of active ingredient. Limited research confirms that Serenade is minimally effective when used alone, but it can provide minimal to moderate suppression of fruit rots when used in rotation with copper products. Efficacy may be improved when mixed with a surfactant.

Black Rot & Frogeye Leaf Spot

CATEGORY: Fungal disease

PATHOGEN: *Diplodia seriata* (formerly *Botryosphaeria obtusa*)

DAMAGE: Branch cankers and fruit decay (black rot); leaf spots (frogeye)



Nicole Ward Gauthier, University of Kentucky

DESCRIPTION

Black rot affects leaves, fruit, and branches. Leaf spots appear 1 to 3 weeks after petal fall, although infections can occur as bud scales loosen in early spring. The resulting purple-colored leaf spots reach 1/4 inch in diameter, and then spot centers turn tan and fall out. Fruit infections occur from bloom until 4 to 6 weeks after petal fall. Often, immature fruit drop within this period. Some fruit continue to develop, with fruit rot on the calyx end developing 3 to 6 weeks before harvest. Brown lesions remain firm and are not sunken. Fungal fruiting structures (pycnidia) are produced across fruit lesions. Infected fruit shrivel and remain attached to trees. Branches may also become infected and develop cankers.



Symptoms such as cankers and leaf spots reduce tree vigor, affecting yield potential. Infected fruit decay and become unmarketable. Stressed and/or damaged trees are more susceptible to infection.

IMPORTANCE

Minor – Black rot may cause 10% to 25% yield loss in orchards where sanitation practices are neglected and the pathogen is allowed to establish. The fungal pathogen that causes black rot is capable of infecting more than 100 different tree and shrub species. Inoculum is commonly present and widespread throughout Kentucky.

MANAGEMENT

Critical Timing of Management Practices

Infections occur in early spring, possibly before bloom. Early season management is critical, especially if the orchard has a history of black rot or frog-eye leaf spot. Sanitation practices should be carried out throughout the season, especially during winter or early spring before bloom. Removing fallen fruit, mummies, and cankered branches eliminates potential inoculum sources.

Cultural Practices

- Prune disease/dead twigs and branches from trees during dormancy (late autumn to early spring). Dispose of all pruned tissues by taking off site or by burning.
- Remove and dispose of all mummified fruit and fallen/infected fruit throughout the season.
- Protect trees and fruit from injury, such as insect feeding and mechanical damage.
- Avoid cultivars that are sensitive to cold damage and to fire blight.
- Consider disease susceptibility when selecting cultivars:
 - Least susceptible – Fuji, Gala Supreme, Golden Delicious, Gold Rush, and Enterprise.
 - Susceptible – Ginger Gold.
 - Highly susceptible – Empire, Pristine, and Red Delicious.

Fungicides

Fungicide sprays begin at bloom and continue until second cover. Currently there are no fungicide resistance issues reported for black rot. Fungicides containing captan may provide a moderate risk to pollinators. Limited research suggests that products containing mancozeb or ziram may also be toxic to pollinators if applied during bloom.

BLACK ROT & FROGEYE LEAF SPOT

FUNGICIDES LABELED FOR MANAGEMENT OF BLACK ROT AND FROGEYE LEAF SPOT ON APPLE.

Fungicide	FRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Captan 80WDG, 4L, or 50WP (captan)	M	foliar/canopy application	5 lbs. per acre	good	0 days	24 hours to 4 days	Most products have a REI of 24 hours, but some have 4 days. Moderate risk to pollinators.
Flint 50WG (trifloxystrobin)	11	foliar/canopy spray	2-2.5 oz. per acre	good	14 days	12 hours	Do not use with organosilicate surfactants. See note ³
Luna Sensation (fluopyram + trifloxystrobin)	7+11	foliar/canopy spray	4-5.8 fl. oz. per acre	good	14 days	12 hours	
Mancozeb 75DF (mancozeb)	M	foliar/canopy spray	3 lbs. per acre	good	77 days	24 hours	Do not apply more than 24 lbs. (prebloom applications)/21 lbs. (extended protectant program) per acre per year. May be toxic to pollinators. See note ³
Merivon (fluxapyroxad + pyraclostrobin)	7+11	foliar/canopy spray	4-5.5 fl. oz. per acre	good	0 days	12 hours	Do not apply with captan or emulsifiable concentrates (EC) or oil-based products.
Pristine 38WG (pyraclostrobin + boscalid)	7+11	foliar/canopy spray	14.5-18.5 oz. per acre	good	0 days	12 hours	See note ³
Sovran 50WG (kresoxim-methyl)	11	foliar/canopy spray	4-6.4 oz. per acre	good	30 days	12 hours	See note ³
Sulfur	M	foliar/canopy spray		fair	0 days	24 hours	
Topsin-M 70WSB (thiophanate-methyl)	1	foliar/canopy spray	1-1.5 lbs. per acre	good	0 days	12 hours	May cause scarf skin on Rome apples if applied within a 4-week period following petal fall. Excessive use can adversely affect predatory mites.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³ Note: Limited number of applications or other restrictions apply.

Biological Methods

Biofungicides are recent introductions to the mainstream commercial product market. Limited research is available regarding efficacy, although

performance is often minimal to moderate in comparison to synthetic fungicides. Cultural practices, especially sanitation, are essential for performance of these products.

BIOFUNGICIDES LABELED FOR MANAGEMENT OF BLACK ROT AND FROGEYE LEAF SPOT ON APPLE.

Biofungicide	Application Method	Rate	Comments
Actinovate AG (<i>Streptomyces lydicus</i> strain WYEC 108)	Foliar/canopy spray every 7 to 14 days	3-12 oz. per acre	OMRI listed. Use with spreader sticker. Limited research confirms that Actinovate AG is not effective when used alone, but it can provide minimal to moderate suppression of fruit rots when used in rotation with copper products.
Double Nickel 55 (<i>Bacillus amyloliquefaciens</i> strain D747)	Foliar/canopy spray every 7 to 10 days	0.25-3.0 lbs. per acre	OMRI listed. Limited research confirms that Double Nickel is not effective when used alone, but it can provide minimal to moderate suppression of fruit rots when used in rotation with copper products.
Serenade (QST 713 strain of <i>Bacillus subtilis</i>)	Foliar/canopy spray		OMRI listed. Various formulations are available (ASO, Max, Opti) at various concentrations of active ingredient. Limited research confirms that Serenade is minimally effective when used alone, but it can provide minimal to moderate suppression of fruit rots when used in rotation with copper products. Efficacy may be improved when mixed with a surfactant.

Fire Blight

CATEGORY: Bacterial disease

PATHOGEN: *Erwinia amylovora*

DAMAGE: Causes blossom blight, shoot blight, and cankers



Nicole Ward Gauthier, University of Kentucky

DESCRIPTION

Fire blight is a bacterial disease with three distinct phases. Blossom blight occurs during bloom, causing collapse and rapid death of blossoms and/or spurs. This blossom infection stage is most severe when weather is warm and wet during bloom. Shoot blight occurs several weeks after bloom, with symptoms occurring on rapidly growing shoots. Infected shoots turn black from the tip, causing the tip to bend over forming a typical shepherd's crook. Canker phase begins at locations where spurs or infected branches intersect with larger branches. Cankers are usually visible beginning in late spring or early summer, and expand with age. Advanced branch and trunk cankers usually contain black, sunken areas covered with loose, peeling bark.



Blossoms lost as a result of fire blight impact yield potential. If left unmanaged, the disease progresses to branches and trunks; tree death can result.

IMPORTANCE

Major – Commercial growers identified fire blight as the disease most likely to impact yield and the most difficult to manage. Common cultivars have varying degrees of susceptibility. Severity is dependent upon weather conditions during tree bloom. Incidence varies from orchard to orchard and from one cultivar to another, depending upon stage of bloom and conditions during bloom. As much as 50% to 80% of acreage may be affected at varying degrees of severity each year. Plant species, such as cotoneaster, crabapple, hawthorn, and pear, can also be affected by fire blight and may provide sources of inoculum.

MANAGEMENT

Critical Timing of Management Practices

The fire blight bacterium is active in early spring when temperatures begin to warm. Optimum temperatures (65° to 70°F) and rainy conditions favor infection. Pruning during dormancy is critical for reduction of inoculum for subsequent growing seasons. Antibiotic applications should begin at bloom and continue through petal fall. Copper applications are recommended during silver tip.

Cultural Practices

- Select resistant cultivars and resistant cultivar/rootstock combinations (see table).
- Prune trees to improve air circulation and promote rapid drying of foliage.
- Prune blighted twigs or infected woody tissue during tree dormancy. Remove and destroy all pruned material. Clean tools between pruning cuts. Never prune while trees are wet or work in the rain.
- Avoid practices that stimulate rapid tree growth.
- Remove alternate hosts for fire blight such as crabapple and pear.

RATING OF COMMON CULTIVARS AND ROOTSTOCKS FOR FIRE BLIGHT SUSCEPTIBILITY.

	Susceptible	Moderately Resistant	Highly Resistant
Cultivars	Fuji	Dayton	Jonafree
	Gala	Empire	Liberty
	Golden Delicious	Goldrush	Pricilla
	Idared	Jonamac	Redfree
	Jonathan	Red Delicious	Sundance
	Lodi		Winesap
	Mutsu		
	Rome Beauty		
Root stocks	Malling ¹	Malling-Merton ²	Geneva-Cornell ³
	Budagovky ⁴		

¹Includes M7, M9

²Includes MM111

³Includes G41, G202, G935

⁴Includes Bud9, which has been considered moderately resistant; however, recent reports indicate that this rootstock is becoming increasingly susceptible.

Bactericides

Antimicrobial sprays (copper) should be applied at silver tip. Antibiotic applications should begin at bloom and continued through petal fall. Applications should be timed according to risk. Prediction models that use localized weather data can help growers determine that level of risk; growers are encouraged to regularly check the

model in order to determine when bactericide applications are necessary. If prediction models are utilized, the first application may be delayed and/or bactericide applications eliminated.

There are no reports of bactericide resistance in Kentucky. However, resistance to streptomycin has been confirmed in Michigan and New York, as well as various states on the West Coast.

BACTERICIDES LABELED FOR MANAGEMENT OF FIRE BLIGHT ON APPLE.

Bactericide/ Antimicrobial	FRAC	Application Method	Rate	Comments
Copper (Fixed copper fungicides, copper hydroxide, copper oxychloride, basic copper sulfate, Bordeaux mixture, cuprous oxide)	M	foliar/canopy spray	rates vary for different products	Many formulations are OMRI listed. Do not apply after ¼-inch green leaf stage or when drying conditions are cool and slow or injury can result. Fixed coppers can be mixed with oil; never combine copper sulfate with dormant oil.
FireLine 17WP (oxytetracycline)	41	foliar/canopy spray	200 ppm	Product registered for fire blight control, but only recommended in orchards with a history of streptomycin resistance. See note ³
Kasumin 2L (kasugamycin)	24	foliar/canopy spray	64 fl. oz. per 100 gal.	Do not exceed two sequential treatments per year. Product registered for fire blight control, but only needed in orchards with a history of streptomycin resistance.
Mycoshield (oxytetracycline)	41	foliar/canopy spray	200 ppm (equal to 1 lb. per 100 gals.)	Product registered for fire blight control, but only recommended in orchards with a history of streptomycin resistance. See note ³
Streptomycin 17WP, Agromycin, and generics (streptomycin)	25	foliar/canopy spray	1.5 lbs. per acre	PHI ¹ = 50 days, REI ² = 12 hours. Start fire blight sprays at first sign of open blossom. Repeat sprays at 4-5 day intervals through bloom and petal fall on susceptible varieties. Minimum of two applications are necessary to provide control. If warm, wet weather occurs, it is critical to apply sprays on a tight schedule using a maximum strength of 100 ppm (8 oz. per 100 gals.). Not recommended for use after petal fall. Fire blight resistance to streptomycin has been reported in other states, but not in Kentucky. Alternatively, mix Streptomycin 17 WP (1 lb. per acre) and Regulaid surfactant (1 pt. per acre) for improved wetting, coverage, and penetration.
Growth regulator Apogee 27.5W (prohexadione-calcium) + Regulaid		foliar/canopy spray	10-12 oz. per 100 gals. per acre / 1 pt. per acre	Apogee PHI ¹ = 45 days, REI ² = 12 hours. Apply at full bloom to early petal fall to reduce the threat of fire blight on shoots. If mixing in water high in calcium carbonate, add 1 lb. of spray-grade ammonium sulfate for each pound of Apogee. Do not tank mix Apogee with boron, calcium, chloride, or calcium nitrate.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³ Note: Limited number of applications or other restrictions apply.

Biological Methods

Biological products are recent introductions to the mainstream commercial product market. Limited research is available regarding efficacy,

although performance is often minimal to moderate in comparison to antibiotics. Cultural practices, especially sanitation, are essential for performance of these products.

BIOLOGICAL PRODUCTS LABELED FOR MANAGEMENT OF FIRE BLIGHT ON APPLE.

Biological Product	Application Method	Rate	Comments
Actinovate AG (<i>Streptomyces lydicus</i> strain WYEC 108)	Blossom spray; apply every 7 to 14 days	3-12 oz. per acre	OMRI listed. Use with spreader sticker. Limited research confirms that Actinovate AG is only minimally effective at suppressing fire blight under high disease pressure.
Blossom Protect (<i>Aureobasidium pullulans</i> strains DSM14940 and DSM 14941)	Blossom spray	1.25 lbs. per acre	Apply up to four treatments at 10%, 40%, 70%, and 90% bloom while maintaining agitation. Limited research confirms that Blossom Protect is minimally to moderately effective at suppressing fire blight when used alone (plus buffering agent Buffer Protect) or when used in rotation with an experimental bacteriophage product. May cause russetting if applied during late blossom and wet conditions.
Double Nickel 55 (<i>Bacillus amyloliquefaciens</i> strain D747)	Blossom spray; apply every 7 to 10 days	0.25-3.0 lbs. per acre	OMRI listed. Limited research confirms that Double Nickel is minimally effective at suppressing fire blight when used alone, but moderately effective when used in rotation with streptomycin (not OMRI listed).
Serenade (QST 713 strain of <i>Bacillus subtilis</i>)	Blossom spray		OMRI listed. Various formulations are available (ASO, Max, Opti) at various concentrations of active ingredient. Limited research confirms that Serenade may provide moderate control of fire blight when used in rotation with copper products, but minimal control when used alone. Efficacy may be improved when mixed with Regulaid surfactant, but this combination does not meet organic certification standards.

Root / Collar Rot

CATEGORY: Water mold/fungus-like organism disease

PATHOGEN: *Phytophthora cactorum*, *Phytophthora* spp.

DAMAGE: Causes decay of roots and/or lower trunk



Mark Lonstroth, Michigan State University

DESCRIPTION

Root or collar rot is first noticed by above-ground symptoms. Stunting or unhealthiness of trees may begin with small yellow leaves that turn reddish-purple later in the season. Cankers develop at the soil line, but may not be noticeable until removal of bark. Bark may be dark-colored and soft, and underlying wood is reddish-brown and often slimy. Initially, trees experience reduced vigor and yield. Decay eventually girdles trees, and trees often die within 1 to 3 years.



IMPORTANCE

Minor – Root and collar rot occurs infrequently in orchards and is limited to locations with poor drainage or heavy soils. It is more prevalent in young trees and newly established orchards.

MANAGEMENT

Cultural Practices & Physical Methods

- Select a site with well-drained soil.
- Make improvements to both surface and subsurface drainage before planting.
- Select disease resistant rootstock.

Fungicides

Drenches can be used to suppress development of root and collar rots. Currently there are no resistance issues reported for the this disease pathogen.

ROOT / COLLAR ROT

FUNGICIDES LABELED FOR MANAGEMENT OF ROOT / COLLAR ROT

Fungicide	Application Method	Rate	Comments
Aliette 80 WDG, Agrifos, Prophyt (phosphoric acid)	foliar spray	5 lbs. per 100 gals. every 60 days (3-4 sprays per season) or 2.5 lbs. per 100 gals. every 30 days (6-8 sprays per season)	Apply in spring once sufficient foliage is present. Do not apply more than 5 lbs. per acre per application. Do not exceed 20 lbs. per acre per season. Do not apply if copper based fungicides have been applied within 2 weeks to avoid phytotoxicity.
Ridomil Gold SL	applied to soil in early spring before growth starts	2 qts. or 1.5 oz. per 1,000 sq. ft.	Applications should be made before symptoms appear. Ridomil will not revitalize trees showing moderate to severe crown rot symptoms. Second application should be made in autumn after harvest, but prior to ground freezing. Delay first application until 2 weeks after new planting. Tree roots should not be dipped or sprayed with Ridomil. Do not graze or feed cover crops from treated orchards.

Rust

(Cedar-apple, Cedar-quince, Cedar-hawthorn)

CATEGORY: Fungal disease

PATHOGENS: *Gymnosporangium juniper-virginianae*,
G. clavipes, *G. globosum*

DAMAGE: Affects leaves and fruit



John Strang, University of Kentucky

DESCRIPTION

Cedar-apple, cedar-quince, and cedar-hawthorn rust diseases have similar symptoms and life cycles. Rusts overwinter as galls on cedar or juniper species. In spring, teliospores (one of several spore types) are released from galls. Teliospores produce basidiospores (a different type of spore), which then infect apple leaves and fruit. Once infected, small yellow spots develop on upper leaf surfaces in spring, before or shortly after bloom. Leaf spots enlarge, turning orange to yellow. Black fruiting structures (pycnia) appear in spots on upper sides of leaves, and then in late summer, cylindrical tubes (aecial cups) form on undersides of leaves. Spores (aeciospores) produced in aecial cups infect juniper and cedar in late summer.

Nicole Ward Gauthier, University of Kentucky



Nicole Ward Gauthier, University of Kentucky

John Strang, University of Kentucky



John Strang, University of Kentucky

Fruit infected by basidiospores in spring develop symptoms near calyx ends of fruit that resemble leaf lesions. There is only one infection period for each spore type per season.

Leaf infections weaken trees and result in a reduction in fruit size and quality of the current crop, as well as reduced bloom the following year. Heavy infections occurring over several consecutive years result in stunting, increased susceptibility to winter injury, and failure to produce fruit. Infected fruit may drop prematurely, while those that remain on trees until harvest have reduced market value. Fruit infections are usually not a problem for Kentucky growers, but leaf infections are common.

IMPORTANCE

Moderate to Major – Apple-juniper rusts are ubiquitous to Kentucky. The diseases can be major threats to susceptible cultivars; however, most commercial growers effectively manage rust diseases. There are no reports of disease losses in commercial orchards. However, home orchards are frequently affected. Cedar-apple rust is the most common and most economically important rust disease occurring on apple in Kentucky. Cedar-hawthorn rust and cedar-quince rust are of lesser importance on apple, but they occur in Kentucky.

MANAGEMENT

Critical Timing of Management Practices

Management should begin at the pink-bud stage, as most infections occur within the first 30 days after bloom.

Cultural Practices

- Select resistant cultivars, such as Redfree, Liberty, Nova Easygro, Spartan, Macfree, Priscilla, Enterprise, or Sundance.
- Select juniper cultivars with resistance or immunity to rust for use in nearby landscapes.
- Destroy nearby unmanaged, abandoned, or wild apple, crabapple, cedar, or juniper trees.
- Prune and destroy cedar apples found on ornamental junipers and cedars, when practical.

Fungicides

Fungicide sprays should begin at tight cluster and continue through second cover. Currently there are no fungicide resistance issues reported for rust of apple. Limited research suggests that products containing mancozeb or ziram may also be toxic to pollinators if applied during bloom.

FUNGICIDES LABELED FOR MANAGEMENT OF CEDAR RUSTS ON APPLE.

Fungicide	FRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Flint 50WG (trifloxystrobin)	11	foliar/canopy spray	See comments	good	14 days	12 hours	Rate: 2.5 oz. per acre (tight cluster through petal fall); 2-2.5 oz. per acre (1 st and 2 nd cover) Do not use with organosilicate surfactants. See note ³
Fontelis (penthiopyrad)	7	foliar/canopy spray	See comments	good	28 days	12 hours	Rate: 14-20 fl. oz. per acre (tight cluster through petal fall); 16-20 fl. oz. per acre (1st and 2nd cover)
Indar 2F or 75WSP (fenbuconazole)	3	foliar/canopy spray	6 oz. per acre	good	14 days	12 hours	See note ³
Inspire Super (difenoconazole + cyprodinil)	3+9	foliar/canopy spray	See comments	excellent	14 days	12 hours	Rate: 4-6.4 oz. per acre (tight cluster through petal fall); 12 fl. oz. per acre (1 st and 2 nd cover)
Luna Sensation (fluopyram + trifloxystrobin)	7+11	foliar/canopy spray	4-5.8 fl. oz. per acre	good	14 days	12 hours	
Mancozeb 75DF (mancozeb)	M	foliar/canopy spray	3 lbs. per acre	good	77 days	24 hours	Do not apply more than 24 lbs. (prebloom applications)/21 lbs. (extended protectant program) per acre per year. May be toxic to pollinators. See note ³

¹ PHI = Pre-harvest interval² REI = Re-entry interval³ Note: Limited number of applications or other restrictions apply.

FUNGICIDES LABELED FOR MANAGEMENT OF CEDAR RUSTS ON APPLE. (CONT'D)

Fungicide	FRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Merivon (fluxapyroxad + pyraclostrobin)	7+11	foliar/canopy spray	4-5.5 fl. oz. per acre	fair to good	0 days	12 hours	Do not apply with captan, EC, or oil-based products.
Pristine 38WG (pyraclostrobin + boscalid)	7+11	foliar/canopy spray	14.5-18.5 oz. per acre	excellent	0 days	12 hours	See note ³
Procure 50WP (triflumizole)	3	foliar/canopy spray	12-16 oz. per acre	excellent	14 days	12 hours	
Rally 40 WSP (myclobutanil)	3	foliar/canopy spray	2.5-6 oz. per acre	excellent	14 days	24 hours	
Sovran 50WG (kresoxim-methyl)	11	foliar/canopy spray	See comments	excellent	30 days	12 hours	Rate: 2-2.5 oz. per acre (tight cluster through petal fall); 4-6.4 oz. per acre (1 st and 2 nd cover). Do not use with organosillicate surfactants. See note ³
Topguard (flutriafol)	3	foliar/canopy spray	8-12 oz. per acre	excellent	14 days	12 hours	See note ³
Ziram 76DF (ziram)	M	foliar/canopy spray	6-8 lbs. per acre	excellent	14 days	48 hours	Do not exceed 32.2 lbs. a.i. per acre or 7 applications per crop cycle. May be toxic to pollinators.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³ Note: Limited number of applications or other restrictions apply.

Biological Methods

Biofungicides are recent introductions to the mainstream commercial product market. Limited research is available regarding efficacy, although

performance is often minimal to moderate in comparison to synthetic fungicides. Cultural practices, especially sanitation, are essential for protection and performance of these products.

BIOFUNGICIDES LABELED FOR MANAGEMENT OF CEDAR RUSTS ON APPLE.

Biofungicide	Application Method	Rate	Comments
Actinovate AG (<i>Streptomyces lydicus</i> strain WYEC 108)	Foliar/canopy spray every 7 to 14 days	3-12 oz. per acre	OMRI listed. Use with spreader sticker. Limited research confirms that Actinovate AG is not effective when used alone, but it can provide minimal to moderate suppression of rust when used in rotation with copper products.
Double Nickel 55 (<i>Bacillus amyloliquefaciens</i> strain D747)	Foliar/canopy spray every 7 to 10 days	0.25-3.0 lbs. per acre	OMRI listed. Limited research confirms that Double Nickel is not effective when used alone, but it can provide minimal to moderate suppression of rust when used in rotation with copper products.
Serenade (QST 713 strain of <i>Bacillus subtilis</i>)	Foliar/canopy spray		OMRI listed. Various formulations are available (ASO, Max, Opti) at various concentrations of active ingredient. Limited research confirms that Serenade is not effective when used alone, but it can provide minimal to moderate suppression of rust when used in rotation with copper products. Efficacy may be improved when mixed with a surfactant.

Scab

CATEGORY: Fungal disease

PATHOGEN: *Venturia inaequalis*

DAMAGE: Affects leaves and fruit



Nicole Ward Gauthier, University of Kentucky

DESCRIPTION

Primary lesions of apple scab appear on the undersides of leaves as early as flowering. Symptoms begin as velvety, brown or olive-colored spots with feathery, undefined edges. Later, spots appear on both sides of leaves, become more distinct, and turn black and corky or scab-like with age. Secondary infections occur if primary infections are not properly controlled and repeating spores (conidia) infect healthy tissue. Fruit symptoms are similar to those on leaves, although fruit spots may be more distinctly outlined. Older lesions turn dark brown to black, develop a corky appearance, and frequently become cracked as fruit enlarge. If infections occur on young fruit, uneven growth near “scabs” may cause fruit to become severely deformed. Heavily infected fruit may drop prematurely.



Losses result from reduced fruit quality and from premature drop of infected fruit. Defoliation causes a general weakening of the host. Summer defoliation may result in reduced tree vigor the next spring.

IMPORTANCE

Minor – Apple scab is not a significant problem for apple growers in Kentucky, even in cultivars with limited resistance. Scab is rarely present in apple, even in unsprayed orchards. However, scab is a severe disease of many common flowering crabapple cultivars in Kentucky. This disease also occurs on hawthorn and mountain ash.

MANAGEMENT

Critical Timing of Management Practices

Infection begins in early spring as leaves emerge.

Cultural Practices

- Select resistant or immune cultivars, such as Enterprise, Gold Rush, Jonafree, Liberty, Macfree, Prima, Priscilla, or Sir Prize.



- Prune trees to improve air circulation, thereby promoting rapid drying of fruit and leaves, and reducing leaf wetness periods. Canopy thinning also allows for more effective spray coverage.
- Destroy fallen leaves and fruit to reduce the amount of overwintering inoculum.
- Mow fallen leaves and apply nitrogen to promote the breakdown of leaf and fungal tissue.

Fungicides

In susceptible cultivars, effective management of scab is dependent upon a preventative fungicide program that begins at bloom. Disease forecasting models are available to determine risk for scab infection and thereby assist with spray timing. The first preventative application should be made once there is a risk for infection to occur and can begin as early as green tip.

Fungicide resistance has been reported for the QoI fungicides (FRAC 11), DMI fungicides (FRAC 3), and one SDHI fungicide (FRAC 7). Fungicides containing captan may provide a moderate risk to pollinators. Limited research suggests that products containing mancozeb or ziram may also be toxic to pollinators if applied during bloom.

FUNGICIDES LABELED FOR MANAGEMENT OF SCAB ON APPLE.

Fungicide	FRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Captan 80WDG, 4L, or 50WP (captan)	M	foliar/canopy spray	See comments	good	0 days	24 hours to 4 days	Rate: 5 lbs. per acre (green tip through 2 nd cover); 2.5-5 lbs. per acre (3 rd cover through remainder of season). REI for most captan products is 24 hours. Some captan products have a 4-day REI. Moderate risk to pollinators.
Flint 50WG (trifloxystrobin)	11	foliar/canopy spray	See comments	excellent	14 days	12 hours	Rate: 2.5 oz. per acre (tight cluster through petal fall); 2-2.5 oz. per acre (1 st cover through remainder of season) Do not use with organosilicate surfactants. Resistance issues reported. See note ³ and note ⁴
Fontelis (penthiopyrad)	7	foliar/canopy spray	See comments	excellent	28 days	12 hours	Rate: 14-20 fl. oz. per acre (tight cluster through petal fall); 16-20 fl. oz. per acre (first cover through remainder of season) Resistance issues reported. See note ⁴
Indar 2F or 75WSP (fenbuconazole)	3	foliar/canopy spray	6 oz. per acre	excellent	14 days	12 hours	Resistance issues reported. See note ³
Inspire Super (difenoconazole + cyprodinil)	3+9	foliar/canopy spray	See comments	excellent	14 days	12 hours	Rate: 4-6.4 oz. per acre (tight cluster through petal fall); 12 fl. oz. per acre (1 st cover through remainder of season)

¹ PHI = Pre-harvest interval² REI = Re-entry interval³ Note: Limited number of applications or other restrictions apply.⁴ Note: Should not be used alone due to risk of resistance development where it does not yet exist.

FUNGICIDES LABELED FOR MANAGEMENT OF SCAB ON APPLE. (CONT'D)

Fungicide	FRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Luna Sensation (fluopyram + trifloxystrobin)	7+11	foliar/canopy spray	4-5.8 fl. oz. per acre	excellent	14 days	12 hours	See note ⁴
Luna Tranquility (fluopyram + pyrimethanil)	7+9	foliar/canopy spray	11.2-16 fl. Oz. per acre	excellent	72 days	12 hours	See note ⁴
Merivon (fluxapyroxad + pyraclostrobin)	7+11	foliar/canopy spray	4-5.5 fl. oz. per acre	excellent	0 days	12 hours	Do not apply with captan, EC, or oil-based products. See note ⁴
Procure 50WP (triflumizole)	3	foliar/canopy spray	12-16 oz. per acre	excellent	14 days	12 hours	Resistance issues reported.
Pristine 38WG (pyraclostrobin + boscalid)	7+11	foliar/canopy spray	14.5-18.5 oz. per acre	excellent	0 days	12 hours	See note ³ and note ⁴
Rally 40 WSP (myclobutanil)	3	foliar/canopy spray	2.5-6 oz. per acre	excellent	14 days	24 hours	Resistance issues reported.
Scala 5SC (pyrimethanil)	9	foliar/canopy spray	7-10 fl. oz. per acre	good	72 days	12 hours	Most effective when applied at temperatures below 70°F.
Syllit FL (dodine)	M	foliar/canopy spray	1.5-3 pts. per acre	excellent	7 days	48 hours	High risk for fungicide resistance where frequent use has been common. Apply in combination with Captan (2.0 lbs. per acre) or Mancozeb (2.25 lbs. per acre). See note ³
Topguard (flutriafol)	3	foliar/canopy spray	13 oz. per acre	excellent	14 days	12 hours	Resistance issues reported. Do not use alone in orchards with scab resistance to SI (FRAC 7) fungicides. See note ³
Vanguard 75WG (cyprodinil)	9	foliar/canopy spray	5 oz. per acre	good	0 days	12 hours	Most effective when applied at temperatures below 70°F.
Ziram 76DF (ziram)	M	foliar/canopy spray	6 lbs. per acre	fair	14 days	48 hours	Do not exceed 32.2 lbs. a.i. per acre or 7 applications per crop cycle. May be toxic to pollinators.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³ Note: Limited number of applications or other restrictions apply.

⁴ Note: Should not be used alone due to risk of resistance development where it does not yet exist.

FUNGICIDES LABELED FOR MANAGEMENT OF SCAB ON APPLE. (CONT'D)

Fungicide	FRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Sovran 50WG (kresoxim-methyl)	11	foliar/canopy spray	See comments	excellent	30 days	12 hours	Rate: 2-2.5 oz. per acre (tight cluster through petal fall); 4-6.4 oz. per acre (1 st cover through remainder of season). Do not use with organosilicate surfactants. Resistance issues reported. See note ³ and note ⁴

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³ Note: Limited number of applications or other restrictions apply.

⁴ Note: Should not be used alone due to risk of resistance development where it does not yet exist.

Biological Methods

Biofungicides are recent introductions to the mainstream commercial product market. Limited research is available regarding efficacy, although performance is often minimal to moderate in comparison to synthetic fungicides. Cultural practices, especially sanitation, are essential for the performance of these products.

Post-harvest Management

Five percent urea can be applied in autumn at leaf drop or early spring at a suggested rate of 40 pounds of agricultural grade urea per 100 gallons of water to aid in leaf decomposition.

BIOFUNGICIDES LABELED FOR MANAGEMENT OF SCAB ON APPLE.

Biofungicide	Application Method	Rate	Comments
Double Nickel 55 (<i>Bacillus amyloliquefaciens</i> strain D747)	foliar/canopy spray every 7 to 10 days	0.25-3.0 lbs. per acre	OMRI listed. Limited research confirms that Double Nickel is minimally effective at suppressing scab when used alone, but moderately effective when used in rotation with streptomycin (not OMRI listed).
Serenade (QST 713 strain of <i>Bacillus subtilis</i>)	foliar/canopy spray		OMRI listed. Various formulations are available (ASO, Max, Opti) at various concentrations of active ingredient, applied to blossoms. Limited research confirms that Serenade may provide some control of scab when used in rotation with copper products. Efficacy may be improved when mixed with a surfactant.

Sooty Blotch & Flyspeck

CATEGORY: Fungal disease

PATHOGENS: *Geastrumia polystigmatis*, *Zygothiala jamaicensis*

DAMAGE: Superficial blemishes to fruit



Nicole Ward Gauthier, University of Kentucky

DESCRIPTION

Sooty blotch and flyspeck are two separate diseases that often occur together during summer and autumn. Sooty blotch causes black-brown to olive-colored irregular blotches on fruit. Fruiting structures (pycnidia) appear in darker spots. Flyspeck symptoms appear as sharp, black, shiny dots grouped into clusters. These specks are fruiting structures called pseudothecia. Both pathogens are superficial and are restricted to fruit surfaces; they do not penetrate flesh or cause decay. Losses are attributed to discolorations on fruit and reduced fruit quality.

IMPORTANCE

Moderate – Sooty blotch and flyspeck occur frequently in poorly managed orchards or where air circulation is limited. Under these conditions, diseases can be difficult to manage. Most commercial growers effectively manage sooty blotch and flyspeck with routine fungicide applications that target a range of summer diseases and fruit rots.

MANAGEMENT

Critical Timing of Management Practices

Infections occur in mid- to late-summer. Sanitation practices at the end of the season help remove inoculum sources (fallen fruit, secondary host) for the next season.

Cultural Practices & Physical Methods

- Prune trees to improve air circulation, thereby promoting rapid drying of fruit and leaves and reducing leaf wetness periods. Canopy thinning also allows for more effective spray coverage.
- Adopt sanitation practices to remove bramble hosts and diseased fruit.
- Bag (oriental or Clemson fruit bags) fruit beginning when fruit are 1/2 inch to 3/4 inch in

diameter for protection against late infections. Bags should be applied after fruit are thinned and approximately 1 day after fungicide/ insecticide applications. Remove bags 2 weeks prior to harvest to permit fruit to color. Bagging can be labor-intensive and expensive. Typically fruit bags are only used in organic production and by small scale producers.

Fungicides

Fungicide sprays begin during summer months or at first cover and continue through the remainder of the season. The last one or two applications may be made using a spreader-sticker adjuvant, which may improve disease management. Prediction models are also available to determine risk.

Currently there are no fungicide resistance issues reported for sooty blotch and flyspeck. The fungicide Topsin-M is highly effective in management of sooty blotch and flyspeck, but is known to be toxic to predator mites. Fungicides used for management of sooty blotch and flyspeck are applied late in the season when pollinators are not frequenting orchards.

FUNGICIDES LABELED FOR MANAGEMENT OF SOOTY BLOTCH AND FLYSPECK ON APPLE.

Fungicide	FRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Captan 80WDG, 4L, or 50WP (captan)	M	foliar/canopy spray	2.5-5 lbs. per acre	fair to good	0 days	24 hours to 4 days	REI for most captan products is 24 hours. Some captan products have a 4-day REI.
Flint 50WG (trifloxystrobin)	11	foliar/canopy spray	2-2.5 oz. per acre	excellent	14 days	12 hours	Do not use with organosilicate surfactants. See note ³
Indar 2F (fenbuconazole)	3	foliar/canopy spray	6 oz. per acre	good	14 days	12 hours	See note ³
Inspire Super (difenoconazole + cyprodinil)	3+9	foliar/canopy spray	12 fl. oz. per acre	good	14 days	12 hours	

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³ Note: Limited number of applications or other restrictions apply.

SOOTY BLOTCH & FLYSPECK

FUNGICIDES LABELED FOR MANAGEMENT OF SOOTY BLOTCH AND FLYSPECK ON APPLE. (CONT'D)

Fungicide	FRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Luna Sensation (fluopyram + trifloxystrobin)	7+11	foliar/canopy spray	4-5.8 fl. oz. per acre	good	14 days	12 hours	
Mancozeb 75DF (mancozeb)	M	foliar/canopy spray	3 lbs. per acre	excellent	77 days	24 hours	Do not apply more than 24 lbs. (prebloom applications)/21 lbs. (extended protectant program) per acre per year. See note ³
Merivon (fluxapyroxad + pyraclostrobin)	7+11	foliar/canopy spray	4-5.5 fl. oz. per acre	good	0 days	12 hours	Do not apply with captan or emulsifiable concentrates (EC) or oil-based products.
Pristine 38WG (pyraclostrobin + boscalid)	7+11	foliar/canopy spray	14.5-18.5 oz. per acre	excellent	0 days	12 hours	See note ³
ProPhyt (phosphorous acid) + Captan 80WDG, 4L, or 50WP (captan)	M+33	foliar/canopy spray	4-6 pts. per acre + 5 lbs. per acre				See notes on captan, above.
Sovran 50WG (kresoxim-methyl)	11	foliar/canopy spray	4-6.4 oz. per acre	excellent	30 days	12 hours	Do not use with organosilicate surfactants. See note ³
Topsin-M 70WSB (thiophanate-methyl)	1	foliar/canopy spray	1-1.5 lbs. per acre	excellent	0 days	12 hours	Adverse effect on predatory mites.
Ziram 76DF (ziram)	M	foliar/canopy spray	6 lbs. per acre	fair to good	14 days	48 hours	Do not exceed 32.2 lbs. a.i. per acre or 7 applications per crop cycle.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³ Note: Limited number of applications or other restrictions apply.

Biological Methods

Biofungicides are recent introductions to the mainstream commercial product market. Limited research is available regarding efficacy, although

performance is often minimal to moderate in comparison to synthetic fungicides. Cultural practices, especially sanitation, are essential for performance of these products.

BIOFUNGICIDES LABELED FOR MANAGEMENT OF SOOTY BLOTCH AND FLYSPECK ON APPLE.

Biofungicide	Application Method	Rate	Comments
Actinovate AG (<i>Streptomyces lydicus</i> strain WYEC 108)	foliar/canopy spray every 7 to 14 days	3-12 oz. per acre	OMRI listed. Use with spreader sticker. Limited research confirms that Actinovate AG is minimally to moderately effective when used alone, but it can provide good control of sooty blotch/flyspeck when used in rotation with copper products.
Double Nickel 55 (<i>Bacillus amyloliquefaciens</i> strain D747)	foliar/canopy spray every 7 to 10 days	0.25-3.0 lbs. per acre	OMRI listed. Limited research confirms that Double Nickel is minimally to moderately effective when used alone, but it can provide moderate to good control when used in rotation with copper products.
Serenade (QST 713 strain of <i>Bacillus subtilis</i>)	foliar/canopy spray		OMRI listed. Various formulations are available (ASO, Max, Opti) at various concentrations of active ingredient. Limited research confirms that Serenade is not effective when used alone, but it can provide minimal suppression of sooty blotch/flyspeck when used in rotation with copper products. Efficacy may be improved when mixed with a surfactant.

White Rot

CATEGORY: Fungal disease

PATHOGEN: *Botryosphaeria dothidea*

DAMAGE: Causes fruit decay and branch cankers



John Strang, University of Kentucky

DESCRIPTION

White rot affects both fruit and woody tissue. Fruit rot originates as small circular spots on fruit as they begin to mature, expanding outward and inward as temperatures warm. As disease advances, each rotten area develops a cylindrical rot to the fruit core, making fruit unmarketable. Rotten fruit drop as disease progresses. Fungal spores (conidia) may also infect branches of unhealthy or stressed trees, such as those that are drought-stressed. Pruning cuts, wounds, or natural openings (lenticels) serve as entry points for infection. The fungus also colonizes dead wood, especially those killed by fire blight. Infection is favored by hot weather.



IMPORTANCE

Minor – White rot is more severe in orchards where sanitation practices are neglected and the pathogen is allowed to establish. It causes more losses in the western part of the state where summer temperatures remain above 90°F for longer periods.

MANAGEMENT

Critical Timing of Management Practices

Most infections occur between petal fall and second cover, especially when conditions are warm (optimal 86°F) and wet. During wet years, infections can continue throughout the season. Sanitation practices should be carried out at the end of the growing season to prevent overwintering of inoculum.

Cultural Practices & Physical Methods

- Remove branch cankers and infected limbs, remove fallen fruit.
- Consider disease susceptibility when selecting cultivars:
 - Least susceptible – Honeycrisp
 - Susceptible – Gala Supreme, Ginger Gold, GoldRush, Enterprise, and Fuji.
 - Highly susceptible – Golden Delicious, Pristine, and Rome Beauty
- The white rot fungus is primarily a wound pathogen. Protect trees from mechanical damage, insect borers, and other wounds.
- Avoid drought stress and winter injury, as well as other environmental damage.
- Bag (oriental or Clemson fruit bags) fruit beginning when fruit are 1/2 inch to 3/4 inch in diameter for protection against late infections. Bags should be applied after fruit are thinned and approximately 1 day after fungicide/ insecticide applications. Remove bags 2 weeks prior to harvest to permit fruit to color. Bagging can be labor-intensive and expensive. Typically fruit bags are only used in organic production and by small scale producers.

Fungicides

Fungicide sprays begin at petal fall and continue through harvest; protection against the earliest infections is critical. Currently there are no fungicide resistance issues reported for white rot. The fungicide Topsin-M is known to be effective against white rot, but is also known to be toxic to predator mites. Fungicides containing captan may provide a moderate risk to pollinators.

FUNGICIDES LABELED FOR MANAGEMENT OF WHITE ROT ON APPLE.

Fungicide	FRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Captan 80WDG, 4L, or 50WP (captan)	M	foliar spray/ broadcast	5 lbs. per acre	good	0 days	24 hours to 4 days	REI for most captan products is 24 hours. Some captan products have a 4-day REI. Moderate risk to pollinators.
Flint 50WG (trifloxystrobin)	11	foliar spray/ broadcast	2-2.5 oz. per acre	good	14 days	12 hours	Do not use with organosilicate surfactants. See note ³
Luna Sensation (fluopyram + trifloxystrobin)	7+11	foliar spray/ broadcast	4-5.8 fl. oz. per acre	good	14 days	12 hours	
Mancozeb 75DF (mancozeb)	M	foliar spray/ broadcast	3 lbs. per acre	good	77 days	24 hours	Do not apply more than 24 lbs. (prebloom applications)/21 lbs. (extended protectant program) per acre per year. May be toxic to pollinators. See note ³
Merivon (fluxapyroxad + pyraclostrobin)	7+11	foliar spray/ broadcast	4-5.5 fl. oz. per acre	good	0 days	12 hours	Do not apply with captan or (emulsifiable concentrates (EC) or oil-based products.
Pristine 38WG (pyraclostrobin + boscalid)	7+11	foliar spray/ broadcast	14.5-18.5 oz. per acre	good	0 days	12 hours	See note ³
Sovran 50WG (kresoxim-methyl)	11	foliar spray/ broadcast	4-6.4 oz. per acre	good	30 days	12 hours	Do not use with organosilicate surfactants. See note ³
Topsin-M 70WSB (thiophanate-methyl)	1	foliar spray/ broadcast	1-1.5 lbs. per acre	good	0 days	12 hours	Adverse effect on predatory mites. May cause scarf skin on Rome apples if applied within a 4-week period following petal fall. Combine with Captan 80 WDG/4L/50WP (4 lbs. per acre), Mancozeb 75DF (3 lbs. per acre), or Polyram 80DF (3 lbs. per acre).

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³ Note: Limited number of applications or other restrictions apply.

Biological Methods

Biofungicides are recent introductions to the mainstream commercial product market. Limited research is available regarding efficacy, although

performance is often minimal to moderate in comparison to synthetic fungicides. Cultural practices, especially sanitation, are essential for performance of these products.

BIOFUNGICIDES LABELED FOR MANAGEMENT OF WHITE ROT ON APPLE.

Biofungicide	Application Method	Rate	Comments
Actinovate AG (<i>Streptomyces lydicus</i> strain WYEC 108)	foliar/canopy spray every 7 to 14 days	3-12 oz. per acre	OMRI listed. Use with spreader sticker. Limited research confirms that Actinovate AG is not effective when used alone, but it can provide minimal to moderate suppression of fruit rots when used in rotation with copper products.
Double Nickel 55 (<i>Bacillus amyloliquefaciens</i> strain D747)	foliar/canopy spray every 7 to 10 days	0.25-3.0 lbs. per acre	OMRI listed. Limited research confirms that Double Nickel is not effective when used alone, but it can provide minimal to moderate suppression of fruit rots when used in rotation with copper products.
Serenade (QST 713 strain of <i>Bacillus subtilis</i>)	foliar/canopy spray		OMRI listed. Various formulations are available (ASO, Max, Opti) at various concentrations of active ingredient. Limited research confirms that Serenade is minimally effective when used alone, but it can provide minimal to moderate suppression of fruit rots when used in rotation with copper products. Efficacy may be improved when mixed with a surfactant.

Infection Periods

Infection periods and critical times for fungicide/bactericide applications in commercial orchards in Kentucky.

	Fire Blight	Bitter Rot	Rust	Scab	Sooty Blotch/ Fly Speck	Black Rot	White Rot
Dormant to Silver Tip	+						
Green Tip to Half Inch Green				+			
Tight Cluster			+	+		+	
Pink			+	+		+	
Bloom	+		+	+		+	
Petal Fall	+	+	+	+		+	+
First Cover		+	+		+	+	+
Second Cover		+			+	+	+
Third Cover		+			+		+
Summer Cover Sprays		+			+		+

Cultivar Disease Susceptibility

Disease susceptibility of the top ten apple cultivars grown in Kentucky commercial orchards. The cultivars are listed in order of acreage, from high to low.

	Fire Blight	Bitter Rot	Rust	Scab
Golden (Yellow) Delicious	S	VS-S	S	S
Gala	VS	S	S	VS
Honeycrisp	R	VS	S	MR
Fuji	VS	VS	S	S
Winesap	VR	R	R	VS
Red Delicious	R	MS	VR	S
Jonathan	VS	S	S	S
Gold Rush	R	S	S	VR
Granny Smith	VS	VS	R	S
Lodi	VS	MS-R	MS	S

VS - very susceptible

S - susceptible

MS - moderately susceptible

R - resistant/tolerant/minimally susceptible

VR - very resistant

Grower Survey Results

A survey of Kentucky growers resulted in the following rating of disease importance and management challenges.

Yield Loss/Importance		Management Difficulty	
1	Fire blight	1	Fire blight
2	Bitter rot	2	Bitter rot
3	Rust	3	Sooty Blotch/Fly Speck
3	Fruit rots (general, unidentified)	3	Rust
4	Sooty blotch/Fly speck	4	Fruit rots (general, unidentified)
5	Scab	5	Scab

Resources

- IPM Scouting Guide for Common Problems of Apple, University of Kentucky (ID-219)
<http://www2.ca.uky.edu/agcomm/pubs/ID/ID219/ID219.pdf>
- Midwest Fruit Pest Management Guide (ID-232)
<http://plantpathology.ca.uky.edu/files/id-232.pdf>
- Apple Scab (PPFS-FR-T-13)
<http://plantpathology.ca.uky.edu/files/ppfs-fr-t-13.pdf>
- Apple Rust Diseases (PPFS-FR-T-05)
<http://plantpathology.ca.uky.edu/files/ppfs-fr-t-05.pdf>
- Characterization of Colletotrichum Species Causing Bitter Rot of Apple in Kentucky Orchards (2016)
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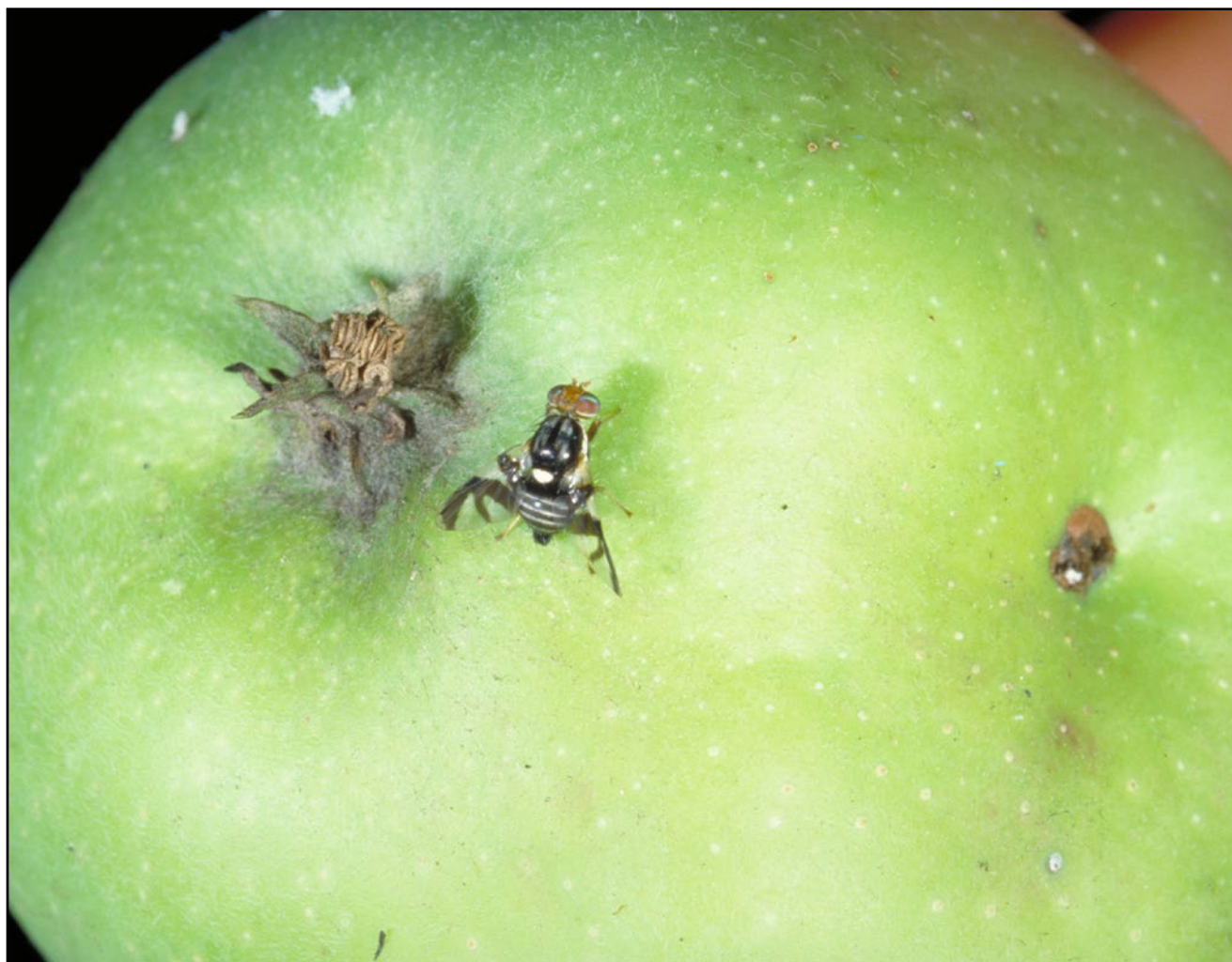
Apple Maggot

CATEGORY: Insect

SCIENTIFIC NAME: *Rhagoletis pomonella*

ORDER: Diptera

DAMAGE: Tunnel into fruit



Ric Bessin, University of Kentucky

DESCRIPTION

Adult apple maggots are small flies about 1/4 inch long. They have a dark thorax with a white spot on the tip, a dark abdomen with white cross bands, and four dark streaks on wings. Mature larvae are 1/3 inch long, cream-colored, legless, and lack a distinct head. Larvae burrow into apples, resulting in irregular tunnels in the flesh and an uneven surface to the fruit. Apple maggot adults emerge from soil in mid-June.



IMPORTANCE

Minor - Apple maggots are primarily a backyard problem where fewer insecticides are used. In commercial orchards, routine management practices used for other pests often lower apple maggot populations and prevent them from causing economic damage. Estimated yield loss in commercial orchards is 1%.

MANAGEMENT

Critical Timing of Management Practices

Scouting should begin in mid-summer when adult apple maggots emerge from soil.

Monitoring

- Scout for the presence of adult flies by examining fruit and leaves near center of trees.
- Use red or green sphere traps, baited sticky board traps, or yellow sticky cards to monitor populations.

Insecticides

Growers do not specifically target this pest with insecticide treatments. If apple maggot populations increase to significant levels, insecticides should be applied once the first adult flies are detected, usually around the time of third cover spray. Insecticide applications should be applied every 10 to 14 days under dry conditions or every 7 days under rainy conditions. Sprays should continue until late-September or until flies are no longer present. There are no insecticide resistance issues reported for apple maggot.

Effects on Beneficials & Pollinators

Insecticides such as carbaryl (IRAC 1A) or pyrethroids (IRAC 3A) are labeled for the management of apple maggots; however, these products have negative effects on predaceous (beneficial) mites.

FUNGICIDES LABELED FOR MANAGEMENT OF APPLE MAGGOT ON APPLE.

Insecticide	IRAC	Application Method	Rate	Efficacy Rating	PHI¹	REI²	Comments
Admire Pro 4.6EC (imidacloprid)	4A	foliar/canopy spray	2.8 fl. oz. per acre	unknown	7 days	12 hours	Moderately toxic to predator mites.
Altacor 35WDG (chlorantran-iliprole)	28	foliar/canopy spray	2.5-4.5 oz. per acre	unknown	5 days	4 hours	Slightly toxic to predator mites. Safe for pollinators.
Assail 30SG (acetamiprid)	4A	foliar/canopy spray	8 oz. per acre	good	7 days	12 hours	Slightly toxic to predator mites.
Belay 2.13SC (clothianidin)	4A	foliar/canopy spray	6 fl. oz. per acre	unknown	7 days	12 hours	Moderately toxic to predator mites.
Imidan 70WP (phosmet)	1B	foliar/canopy spray	2.1-5.3 lbs. per acre	excellent	7 days	72 hours	Slightly toxic to predator mites.
Sevin XLR Plus 4L (carbaryl)	1A	foliar/canopy spray	1.5-3 qts. per acre	good	3 days	12 hours	Highly toxic to predator mites. Cannot be used where growers are routinely mixing low rates of oil into sprays for mite management.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

Brown Marmorated Stink Bug

CATEGORY: Insect

SCIENTIFIC NAME: *Halyomorpha halys*

ORDER: Hemiptera

DAMAGE: Injure fruit



Ric Bessin, University of Kentucky

DESCRIPTION

Adult brown marmorated stink bugs are nearly 3/4 inch long, mottled brown in color with two light bands on each antenna, and a smooth edge between eye and 'shoulder.' It has alternating white and brown spots on the abdomen edge beyond the wings. Nymphs have white bands on their tibia (lower portion of legs). These stink bugs create pockmarks on fruit skin with corresponding hard and pithy areas in the flesh. Damage to fruit is often mistaken for cork spot.



IMPORTANCE

Major – A survey of Kentucky apple growers found that stink bugs (in general) ranked second in both management difficulty and importance to yield loss. It is difficult to separate damage from other stink bugs, so green stink bug (*Chinovia hilare*) and brown stink bug (*Euschistus servus*) are included in this ranking.

The brown marmorated stink bug is an invasive species that is increasing in numbers across the Mid-Atlantic states. In Kentucky, it is more common in eastern and central regions of the state where it has been detected since 2010. As of this printing (2017), the pest is beginning to spread into Western Kentucky. Approximately 60% of Kentucky apple acres are affected, with yield losses between 1% and 2%.

MANAGEMENT

Critical Timing of Management Practices

Brown marmorated stinkbugs are primarily a mid- and late-season pest in most years in the Mid-Atlantic States. Scouting of border rows helps determine whether these insects are present and their estimated population.

Monitoring

Scout and/or employ aggregation pheromone traps to help determine the need for insecticide applications based on established thresholds

(10 per trap per week). Damage is usually higher in the vicinity of pheromone traps.

Physical Methods

Bag (oriental or Clemson fruit bags) fruit beginning when fruit are 1/2 inch to 3/4 inch in diameter for protection against late infestations. Bags should be applied after fruit are thinned and approximately 1 day after fungicide/insecticide applications. Remove bags 2 weeks prior to harvest to permit fruit to color. Bagging can be labor-intensive and expensive. Typically fruit bags are only used in organic production and by small scale producers.

Biological Methods

- There are several native Platygasteridae egg parasitoids that attack low levels of brown marmorated stink bug eggs.
- Egg predation by some Coccinellidae and Orthoptera is beneficial/effective for management of low pest levels.
- A highly effective parasitoid, the Chinese Platygasterid, has been detected in the Mid-Atlantic, but it has not yet been detected in Kentucky.

Insecticides

Insecticide sprays should be applied when threshold levels are reached, usually beginning at the third cover spray. Brown marmorated stink bugs are more difficult to control with insecticides than other stink bug species. As a result, growers are more likely to manage brown marmorated stink bugs with more toxic insecticides that also disrupt natural enemies; these products are also more toxic to mite predators. Currently there are no insecticide resistance issues reported.

Effects on Beneficials & Pollinators

Pyrethroids (IRAC 3A) are effective against brown marmorated stink bug, but these products can severely impact natural enemies. Stink bugs and resulting insecticide applications occur long after bloom, so risk to pollinators is low as long as blooming weeds are mowed before application.

BROWN MARMORATED STINK BUG

INSECTICIDES LABELED FOR MANAGEMENT OF BROWN MARMORATED STINK BUG ON APPLE.

Insecticide	IRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Baythroid XL 1EC (beta-cyfluthrin)	3A	foliar/canopy spray	2-2.4 fl. oz. per acre	good to excellent	7 days	12 hours	Highly toxic to predator mites.
Danitol 2.4 EC (fenpropathrin)	3A	foliar/canopy spray	10.7-21.3 fl. oz. per acre	good to excellent	14 days	24 hours	Highly toxic to predator mites.
Lannate LV (methomyl)	1A	foliar/canopy spray	1.5-3 pts. per acre	good to excellent	14 days	varies	REI varies for different formulations and application rates. Efficacy is excellent with this product, but residual control is relatively short. Highly toxic to predator mites.
Lannate SP (methomyl)	1A	foliar/canopy spray	0.5-1 lb. per acre	good to excellent	14 days	varies	REI varies for different formulations and application rates. Efficacy is excellent with this product, but residual control is relatively short. Highly toxic to predator mites.
Renounce 20WP (cyfluthrin)	3A	foliar/canopy spray	2.5-3 oz. per acre		7 days	12 hours	Highly toxic to predator mites.
Warrior 1CS (lambda-cyhalothrin)	3A	foliar/canopy spray	2.6-5.1 fl. oz. per acre		21 days	24 hours	There is some recovery of stink bugs after treatment. Highly toxic to predator mites.

¹PHI = Pre-harvest interval

²REI = Re-entry interval

Codling Moth

CATEGORY: Insect

SCIENTIFIC NAME: *Cydia pomonella*

ORDER: Lepidoptera

DAMAGE: Burrow into fruit



Ric Bessin, University of Kentucky

DESCRIPTION

Adult codling moths are about 3/8 inch long and gray-colored with distinct bronze areas on the bottom third of their wings. Larvae are found in apple cores, and are pinkish in color with brown heads. Larvae can reach a length of 3/4 inch. Single scale-like eggs are laid on fruit or on adjacent leaves. In Kentucky, codling moth produces three generations per year, each 4 to 6 weeks apart (May, July, August). Apple fruit are damaged by larvae that burrow into fruit and feed extensively in the core, reducing fruit yield.



IMPORTANCE

Major – Kentucky apple growers rank codling moth as the most difficult to manage and the most important insect in terms of yield loss. This pest is ubiquitous throughout the state and can be found in all orchards. Each individual larva attacks a single apple causing loss of marketability. Additionally, codling moth damage can be cryptic and requires significant effort to grade-out at harvest. Thus, presence of codling moth can reduce the reputation of individual orchards where control is poor.

Codling moth are present in all Kentucky orchards, but low levels are maintained through the use of insecticidal programs. Overall, about 1% of apples are lost to codling moth damage.

MANAGEMENT

Critical Timing of Management Practices

Codling moth is the most important insect pest in Kentucky, so basic insecticide spray programs are typically designed around it. Adult codling moth lays eggs in spring as fruit begin to develop. Larva enter fruit during these early stages of fruit development. There are three generations per year, but unlike apple producing regions to

the north, synchronization of the generations in Kentucky is very low. This lack of synchronization results in the need for additional insecticide applications.

- Pheromone traps should be utilized to determine the need for insecticide sprays using established thresholds to time insecticide sprays accordingly.
- Degree day models should be used with biofix dates once a threshold of five adult males are observed in pheromone traps. Models help to calculate time of egg hatch and thus, insecticide spray application. An online degree day model should be used with the biofix information to accurately time these sprays.

Monitoring

Distribute pheromone traps that use chemical lures to attract male moths. Traps should be installed during pink stage of bud development and checked weekly throughout the growing season.

Cultural Practices & Physical Methods

- Remove infested or fallen fruit (sanitation).
- Bag (oriental or Clemson fruit bags) fruit beginning when fruit are 1/2 inch to 3/4 inch in diameter for protection against late infestations. Bags should be applied after fruit are thinned and approximately 1 day after fungicide/insecticide applications. Remove bags 2 weeks prior to harvest to permit fruit to color. Bagging can be labor-intensive and expensive. Typically fruit bags are only used in organic production and by small scale producers.

Biological Methods

- Sex attractant lures can be used to disrupt mating of male and female codling moths. However, due to the annual cost of state registration and limited apple acreage, these technologies are not available in Kentucky.
- Granulosis virus, available as a commercial spray, can be used against larval stage of codling moth. However, due to the annual cost of state registration and limited apple acreage, these technologies are not available in Kentucky.

Insecticides

Insecticide sprays usually begin about the time of first or second cover spray. Insecticide applications should be made every 7 to 10 days for three consecutive applications (usually the first, second, and third cover). Insecticides should be applied every 10 to 14 days for fourth cover and beyond, as this coincides with the start of the second generation.

Because codling moth produces three generations per year, a different mode of action should be used for each generation. Resistance issues have been reported for organophosphates (IRAC 1B). Resistant codling moth populations have been found to be less susceptible to some pyrethroids (IRAC 3A).

Effects on Beneficials & Pollinators

While many pyrethroids (IRAC 3A) provide excellent control of codling moth, their toxicity to mite predators and long residual activity limit their use. Depending upon presence of flowering weeds in the orchard (and thereby presence of foraging pollinators), recommended insecticides can impact beneficial insects, including pollinators.

INSECTICIDES LABELED FOR MANAGEMENT OF CODLING MOTH ON APPLE.

Insecticide	IRAC	Application Method	Rate	Efficacy Rating	PHI¹	REI²	Comments
Altacor 35WDG (chlorantranilip- role)	28	foliar/canopy spray	2.5-4.5 oz. per acre	excellent	5 days	4 hours	This product has a good fit in early to mid-summer when growers are protecting fruit from a group of lepidopteran pests. Typically used 2 to 3 times per year in some orchards. Slightly toxic to predator mites. See note ³
Assail 30SG (acetamiprid)	4A	foliar/canopy spray	8 oz. per acre	excellent	7 days	12 hours	Good rain-fast residual activity. Generally used either early in the season after petal fall (controls plum curculio and codling moth) or close to harvest (short PHI). Typically used 2 to 3 times per year in some orchards. See note ³

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³ Note: Effective against organophosphate-resistant populations

INSECTICIDES LABELED FOR MANAGEMENT OF CODLING MOTH ON APPLE. (CONT'D)

Insecticide	IRAC	Application Method	Rate	Efficacy Rating	PHI¹	REI²	Comments
Confirm 2F (tebufenozide)	18	foliar/canopy spray	20 fl. oz. per acre	fair	14 days	4 hours	Good in early to mid-summer when the common pests are primarily Lepidoptera. Typically used 1 or 2 times per year in some orchards. Slightly toxic to predator mites.
Danitol 2.4 EC (fenpropathrin)	3A	foliar/canopy spray	10.7-21.3 fl. oz. per acre	good to excellent	14 days	24 hours	Also controls phytophagous mites, unlike other pyrethroids used on apples. Many producers use low rates of oil in their sprays to suppress mites throughout the year. Typically used 2 to 4 times per year in some orchards. See note ³
Delegate 25WG (spinetoram)	5	foliar/canopy spray	4.5-7 fl. oz. per acre	excellent	7 days	4 hours	This product fits well in end-of-season applications with its short PHI, particularly in blocks of apples with mixed varieties. Typically used 1 or 2 times per year in some orchards. Moderately toxic to predator mites. See note ³
Imidan 70W (phosmet)	1B	foliar/canopy spray	2.1-5.3 lbs. per acre	good	7 days	72 hours	Resistance issues reported. Reduced efficacy in some orchards where there has been a long history of use. Typically used 2 to 3 times per year in some orchards. Slightly toxic to predator mites.
Intrepid 2F (methoxyfenozide)	18	foliar/canopy spray	12-16 fl. oz. per acre	good	14 days	4 hours	Longer residual activity than alternative insecticides, also good in early to mid-summer when the common pests are primarily Lepidoptera. Slightly toxic to predator mites.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³ Note: Effective against organophosphate-resistant populations

Dogwood Borer

CATEGORY: Insect

SCIENTIFIC NAME: *Synanthedon scitula*

ORDER: Lepidoptera

DAMAGE: Tunnel into trunks



Ric Bessin, University of Kentucky

DESCRIPTION

Dogwood borer adults are a clearwing moth that resembles small wasps. Both fore and hind wings are clear. Thorax and abdomen are dark blue-to-black with yellow bands. Mature larvae are 3/5 inch long and cream-colored with reddish-brown heads and two brown spots on the upper surfaces of front thoracic segments. Larvae tunnel below bark of trunks. A wet area or insect frass may be an indicator of borer wounds. Dogwood borer weakens trees and may create entry wounds for disease pathogens.

James Solomon, USDA, Bugwood .org



John Strang, University of Kentucky



IMPORTANCE

Minor – Kentucky apple growers rank borers low in terms of yield loss and management difficulty. Dogwood borer is an uncommon sporadic pest; fewer than 1% of Kentucky apple acreage is affected by dogwood borer.

MANAGEMENT

Critical Timing of Management Practices

Management should coincide with peak egg hatch to prevent infestation, which usually occurs in late-June.

Monitoring

- Use pheromone traps to monitor presence of dogwood borer adults and estimate size of populations.
- Remove tree guards in early spring to more easily monitor larval activity.

Cultural Practices & Alternative Methods

Growers with limited-acreage sometimes manually remove larvae. However, this practice can cause additional tree damage and is discouraged.

Biological Methods

Entomopathogenic nematodes may be effective for larval control once dogwood borer is established in trunks. These are typically used only in limited-acreage orchards.

Insecticides

Insecticides should be applied as a course spray to soak the trunk at peak egg hatch (typically late June). Pheromone traps can be utilized for monitoring and timing insecticide sprays.

Effects on Beneficials & Pollinators

Insecticides have minimal effects on pollinators because sprays are localized. Products labeled for borer control are applied directly to trunks and lower scaffold limbs; sprays are not applied to fruit or foliage.

INSECTICIDES LABELED FOR MANAGEMENT OF DOGWOOD BORER ON APPLE.

Insecticide	IRAC	Application Method	Rate	Efficacy Rating	PHI¹	REI²	Comments
Lorsban Advanced 3.755 EC (chlorpyrifos)	1B	coarse spray to lower trunk and scaffold limbs to soak bark	1.5 qts. per 100 gallons	excellent	28 days	4 hours	Only use once per year and only in some orchards. Not applied to fruit or foliage. Moderately toxic to predator mites that may be moving from ground to tree.
Lorsban 4 E (chlorpyrifos)	1B	coarse spray to lower trunk and scaffold limbs to soak bark	1.5 qts. per 100 gallons	excellent	28 days	4 hours	Only use once per year and only in some orchards. Not applied to fruit or foliage. Moderately toxic to predator mites that may be moving from ground to tree.
Lorsban 50 W (chlorpyrifos)	1B	coarse spray to lower trunk and scaffold limbs to soak bark	3 lbs. per acre	excellent	28 days	4 hours	Only use once per year and only in some orchards. Not applied to fruit or foliage. Moderately toxic to predator mites that may be moving from ground to tree.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

Eastern Tent Caterpillar

CATEGORY: Insect

SCIENTIFIC NAME: *Malacosoma americanum*

ORDER: Lepidoptera

DAMAGE: Defoliate portions of trees



John Strang, University of Kentucky

DESCRIPTION

Eastern tent caterpillar larvae are hairy and black with a single white stripe down their backs. Caterpillars have brown and yellow lines along their sides with a row of oval blue spots. Eggs are laid the previous summer and serve as the overwintering stage. They hatch in late April/May. Masses of 150 to 400 eggs are covered with shiny black, varnish-like material. Egg masses encircle pencil size or smaller branches. Moths are reddish-brown with two pale stripes running diagonally across each forewing. Eastern tent caterpillars create noticeable tents in trees, resulting in defoliation of young growth in late April and May.



IMPORTANCE

Minor – Kentucky apple growers do not report Eastern tent caterpillar as an important insect in terms of yield loss or management difficulty. While this pest is common, caterpillar levels are low during most years and are typically found in less than 5% of Kentucky orchards. Generally, insecticide sprays used for codling moth and oriental fruit moth control also manage this pest. Every few years, however, there may be localized, destructive populations.

MANAGEMENT

Critical Timing of Management Practices

Management should be timed when tents are small, generally prior to bloom.

Physical Methods

Hand remove tents and caterpillars in small-scale and backyard orchards.

Biological Methods

There is a naturally occurring nuclear polyhedrosis virus that periodically reduces eastern tent caterpillar populations. It is not commercially available.

Insecticides

Growers in Kentucky do not make insecticide applications specifically for this pest. Eastern tent caterpillar is secondarily controlled with insecticides targeting other insects. If insecticides are required, they should be applied before bloom.

European Red Mite

CATEGORY: Insect

SCIENTIFIC NAME: *Panonychus ulmi*

ORDER: Acari

DAMAGE: Injure leaves & fruit buds, reduce tree growth



University of Georgia Plant Pathology, Bugwood.org

DESCRIPTION

Adult female European red mites are brick-red with white spots at the base of six to eight hairs on their backs. Male mites are more slender and lighter in color than females; males also have a more pointed abdomen. Eggs are red, globular, and somewhat flattened with a slender stalk on the upper side. European red mites feed on leaf tissue and cause a gradual silvery, followed by bronzing of leaves. Heavy mite feeding early in the season can reduce tree growth and yield and can also affect fruit bud formation the following year. Some apple cultivars, such as Red Delicious and Braeburn, are more susceptible to mite buildup and injury.



IMPORTANCE

Moderate – Kentucky apple growers rank mites fourth in importance to yield loss and fourth in management difficulty. European red mite can be found in all orchards, but population size and levels of damage can vary.

MANAGEMENT

Critical Timing of Management Practices

Eggs first hatch in spring near the time of bud development (approximately tight cluster stage). Six to eight generations of European red mites can occur per season. Monitoring should begin in spring at initiation of bud growth. Thresholds for mites increase as the season progresses. Mites can be more problematic under hot dry conditions.

Monitoring

Monitor European red mite by examining five hardened-off leaves from each of four scaffold limbs per tree and at least five trees per acre. A hand lens is required to count European red mites. The early season threshold is an average of two to three mites per leaf, and this increases to seven to eight mites per leaf as the season progresses.

Miticides

The use of some insecticides early in the growing season can disrupt natural biological control of mites and lead to economic mite damage. Choose miticides that have low to moderate toxicity to natural enemies of mites. Pyrethroid use should be limited due to toxicity to beneficials. An oil spray should be used at the delayed dormant stage to control European red mites. Many growers use a low level of oil in cover sprays to suppress mites. This reduces the need for a more expensive miticide. Miticides are generally used only when mites exceed thresholds.

Effects on Beneficials & Pollinators

- Many insecticides and miticides have negative effects on predatory mites.
- As mite problems are more likely in mid-summer, miticides have minimal impact on pollinators; however, miticides should be avoided during bloom to protect pollinators.

EUROPEAN RED MITE

MITICIDES LABELED FOR MANAGEMENT OF EUROPEAN RED MITE ON APPLE.

Miticides	IRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Acramite 50WS (bifenazate)	UN	foliar/canopy spray	1 lb. per acre	fair	7 days	12 hours	Slightly toxic to predator mites.
Agri-Mek 0.15EC (abamectin)	6	foliar/canopy spray	10 fl. oz. per acre	good	28 days	12 hours	Most effective if used before leaves harden off. Moderately toxic to predator mites.
Apollo 4SC (clofentezine)	10A	foliar/canopy spray	4-8 fl. oz. per acre	excellent	45 days	12 hours	Slightly toxic to predator mites.
Carzol 92SP (formetanate hydrochloride)	1A	foliar/canopy spray	1-1.25 lbs. per acre	good	varies	5 days	Highly toxic to predator mites. Do not use after petal fall. PHI varies for different formulations and application rates.
Envidor 2SC (spirodiclofen)	23	foliar/canopy spray	16-18 fl. oz. per acre	excellent	7 days	12 hours	Moderately toxic to predator mites.
Kanemite 15SC (acequinocyl)	20B	foliar/canopy spray	21-31 fl. oz. per acre	excellent	14 days	12 hours	Slightly toxic to predator mites.
M-Pede (potassium salts of fatty acids)		foliar/canopy spray	1.2 gals. per acre		0 days	12 hours	OMRI approved. Do not apply when temperatures exceed 90°F. Apply before waxy bloom forms on fruit. Low efficacy when used alone, but enhances other miticides. See note ³
Nealta 1.67L (cyflumetofen)	25	foliar/canopy spray	13.7 fl. oz. per acre	unknown	7 days	12 hours	Toxicity to predator mites unknown.
Nexter 75WP (pyridaben)	21A	foliar/canopy spray	4.4 oz. per acre	good	25 days	12 hours	Highly toxic to predator mites.
Oil (horticultural oil)		foliar/canopy spray	0.5-1% per acre				Do not use if temperatures exceed 90°F. About half of KY growers are using low rates (0.5%) of oils in each cover spray for mite management to avoid use of more costly miticide sprays. See note ³

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³Note: Do not use within 14 days of application of Captan, Sevin, or other sulfur-containing products.

MITICIDES LABELED FOR MANAGEMENT OF EUROPEAN RED MITE ON APPLE. (CONT'D)

Miticides	IRAC	Application Method	Rate	Efficacy Rating	PHI¹	REI²	Comments
Portal 0.4EC (fenpyroximate)	21A	foliar/canopy spray	1-2 pts. per acre	excellent	14 days	12 hours	Moderately toxic to predator mites.
Summer oils (horticultural oil)		foliar/canopy spray	1-2 gals. per acre				Do not use if temperatures exceed 90°F. About half of KY growers are using low rates (0.5%) of oils in each cover spray for mite management to avoid use of more costly miticide sprays. Apply before waxy bloom forms on fruit. See note ³
Vendex 50W (fenbutatin-oxide)	12B	foliar/canopy spray	1-2 lbs. per acre	fair	14 days	48 hours	Slightly toxic to predator mites.
Zeal 72WP (etoxazole)	10B	foliar/canopy spray	2-3 oz. per acre	excellent	14 days	12 hours	Moderately toxic to predator mites.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³Note: Do not use within 14 days of application of Captan, Sevin, or other sulfur-containing products.

Flatheaded Appletree Borer

CATEGORY: Insect

SCIENTIFIC NAME: *Chrysobothris femorata*

ORDER: Coleoptera

DAMAGE: Tunnel into wood, weaken trees



Ric Bessin, University of Kentucky

DESCRIPTION

Adult flatheaded appletree borer beetles are about 1/2 inch long, brownish gray, and flattened. The body is blunt at the head and tapers to a rounded point at the posterior end. Wing covers appear to be finely corrugated. Borers (larvae) are about 1 inch long, legless, yellow-white, and slender, except for a broad, flat enlargement of the thorax directly behind the head. Borers leave 3/16 inch D-shaped holes when emerging from trees. Larvae weaken trees and create entry wounds for disease pathogens.

James Solomon, USDA, Bugwood.org



IMPORTANCE

Minor – Flatheaded apple tree borers were previously a common problem when growers used inter-stem grafted tree systems. They are rarely a problem today. Less than 5% of orchards experience infestations each season.

MANAGEMENT

Critical Timing of Management Practices

Management should be timed before larva become established in trunks.

Cultural Practices

- Reduce tree stress; stressed trees are more susceptible to flatheaded apple tree borer.
- Remove weak and dead wood that may be infested with borers.

Insecticides

If borers are detected, insecticide applications should begin as soon as possible before larvae become established.

Effects on Beneficials & Pollinators

Insecticides have minimal effects on pollinators because sprays are localized. Products are only applied to trunks and lower scaffold limbs; they are not applied to fruit or foliage.

INSECTICIDES LABELED FOR MANAGEMENT OF FLATHEADED APPLETREE BORER ON APPLE.

Insecticide	IRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Lorsban Advanced 3.755 EC (chlorpyrifos)	1B	coarse spray to lower trunk and scaffold limbs to soak bark	1.5 qts. per 100 gallons	excellent	28 days	4 hours	Only use once per year and only in some orchards. Not applied to fruit or foliage. See note ³
Lorsban 4 E (chlorpyrifos)	1B	coarse spray to lower trunk and scaffold limbs to soak bark	1.5 qts. per 100 gallons	excellent	28 days	4 hours	Only use once per year and only in some orchards. Not applied to fruit or foliage. See note ³
Lorsban 50 W (chlorpyrifos)	1B	coarse spray to lower trunk and scaffold limbs to soak bark	3 lbs. per acre	excellent	28 days	4 hours	Only use once per year and only in some orchards. Not applied to fruit or foliage. See note ³

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³ Note: Moderately toxic to predator mites that may be moving from ground to tree

Green June Bug

CATEGORY: Insect

SCIENTIFIC NAME: *Cotinis nitida*

ORDER: Coleoptera

DAMAGE: Feed on fruit



John Strang, University of Kentucky

DESCRIPTION

Adult green June bugs are about 1 inch long with dull metallic green wings and bronze-to-yellow margins on head and sides. Undersides are shiny green. Larvae are cream-colored, up to 2 inches long, and crescent-shaped. Larvae crawl on their backs and project legs upward when moving. Adults attack fruit of early maturing cultivars in July through early August, leaving large holes on surfaces of fruit.



IMPORTANCE

Minor – Kentucky apple growers ranked green June bug as a minor pest. These insects are common throughout the state, but with varying populations each year. Green June bugs appear in low numbers in most years, but they can be more problematic some years. June bugs often invade in conjunction with Japanese beetles; however, while the latter damages foliage and fruit, green June bugs feed only on fruit.

MANAGEMENT

Critical Timing of Management Practices

No control measures are used most years. If management is needed, fruit should be protected in mid-summer.

Physical Methods

Bag (oriental or Clemson fruit bags) fruit beginning when fruit are 1/2 inch to 3/4 inch in diameter for protection against late infestations. Bags should be applied after fruit are thinned and approximately 1 day after fungicide/insecticide applications. Remove bags 2 weeks prior to harvest to permit fruit to color. Bagging can be labor-intensive and expensive. Typically fruit bags are only used in organic production and by small scale producers.

Insecticides

Insecticide sprays should be used if infestations occur, often beginning with early summer cover sprays and reapplying only as needed.

Effects on Beneficials & Pollinators

Use of broad-spectrum insecticides can negatively affect beneficials and natural enemies of other pests. Carbaryl (IRAC 1A) and pyrethroids (IRAC 3A) are known to have negative effects on predaceous mites.

INSECTICIDES LABELED FOR MANAGEMENT OF GREEN JUNE BUG ON APPLE.

Insecticide	IRAC	Application Method	Rate	Efficacy Rating	PHI¹	REI²	Comments
Assail 30SG (acetamiprid)	4A	foliar/canopy spray	5-8 oz. per acre	good	7 days	12 hours	Slightly toxic to predator mites.
Danitol 2.4EC (fenpropathrin)	3A	foliar/canopy spray	16-21.3 fl. oz. per acre	excellent	14 days	24 hours	Highly toxic to predator mites but also has some pest mite control activity.
Imidan 70WP (phosmet)	1B	foliar/canopy spray	2.1-5.3 lbs. per acre	good	7 days	72 hours	Slightly toxic to predator mites.
Mustang Maxx 0.8EC (zeta-cypermethrin)	3A	foliar/canopy spray	1.28-4 fl. oz. per acre		14 days	12 hours	
Neemix 4.5 (azadirachtin)	UN	foliar/canopy spray	7-16 fl. oz. per acre	good	0 days	12 hours	OMRI approved. This is often used if treatment is needed during the harvest period (0 day PHI). Acts as a repellent for about 2 days.
Proaxis 0.5EC (gamma cyhalothrin)	3A	foliar/canopy spray	2.5-5.1 fl. oz. per acre	excellent	21 days	24 hours	Highly toxic to predator mites.
Sevin XLR Plus (4L) (carbaryl)	1A	foliar/canopy spray	1.5-3 qts. per acre	excellent	3 days	12 hours	Highly toxic to predator mites. Not compatible with oil.
Warrior 1CS (lambda-cyhalothrin)	3A	foliar/canopy spray	2.5-5.1 fl. oz. per acre	excellent	21 days	24 hours	Highly toxic to predator mites.

¹PHI = Pre-harvest interval

²REI = Re-entry interval

Japanese Beetle

CATEGORY: Insect

SCIENTIFIC NAME: *Popillia japonica*

ORDER: Coleoptera

DAMAGE: Feed on fruit, skeletonize leaves



Ric Bessin, University of Kentucky

DESCRIPTION

Japanese beetle adults are 3/8-inch-long metallic green beetles with copper-brown wing covers and five small white tufts of hair projecting from underneath wing covers at the tip of the abdomen. Mature larvae are crescent-shaped grubs about 1 inch long with a brown head and grayish-black hind end. The pattern of hairs on the last body segment (raster) form a V-shape near the anal opening. Adults feed on foliage, removing green tissues and skeletonizing leaves. Subsequent defoliation usually has minor effects on long-term tree health.



IMPORTANCE

Minor – Kentucky apple growers ranked Japanese beetle as a minor pest. Japanese beetles are common throughout the state of Kentucky, but affect less than 5% of acreage in typical years. Japanese beetles appear and damage plants any time during the month of July. Populations vary from year to year, so growers may only manage this pest once every 3 or 4 years.

MANAGEMENT

Critical Timing of Management Practices

Early management is important. Control methods should begin within the first 2 weeks Japanese beetles appear. Beetle damage and the insects themselves attract additional beetles.

Monitoring

Pheromone traps are strongly discouraged. Lures attract more adults than the traps capture, resulting in increased populations and more damage than is prevented.

Biological Methods

Larval control products used for turf are not effective for management of adults due to high mobility of individual beetles.

Insecticides

Insecticide sprays should be used as needed, beginning with summer cover sprays and reapplied as needed.

Effects on Beneficials & Pollinators

Carbaryl (IRAC 1A) and pyrethroids (IRAC 3A) are known to have negative effects on predaceous mites.

JAPANESE BEETLE

INSECTICIDES LABELED FOR MANAGEMENT OF JAPANESE BEETLE ON APPLE.

Insecticide	IRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Assail 30SG (acetamiprid)	4A	foliar/canopy spray	5-8 oz. per acre	good	7 days	12 hours	Slightly toxic to predator mites.
Danitol 2.4EC (fenpropathrin)	3A	foliar/canopy spray	16-21.3 fl. oz. per acre	excellent	14 days	24 hours	Highly toxic to predator mites but also has some pest mite control activity.
Imidan 70WP (phosmet)	1B	foliar/canopy spray	2.1-5.3 lbs. per acre	good	7 days	72 hours	Slightly toxic to predator mites.
Mustang Maxx 0.8EC (zeta-cypermethrin)	3A	foliar/canopy spray	1.28-4 fl. oz. per acre		14 days	12 hours	
Neemix 4.5 (azadirachtin)	UN	foliar/canopy spray	7-16 fl. oz. per acre	good	0 days	12 hours	OMRI approved. This is often used if treatment is needed during the harvest period (0 day PHI). Acts as a repellent for about 2 days.
Proaxis 0.5EC (gamma cyhalothrin)	3A	foliar/canopy spray	2.5-5.1 fl. oz. per acre	excellent	21 days	24 hours	Highly toxic to predator mites.
Sevin XLR Plus (4L) (carbaryl)	1A	foliar/canopy spray	1.5-3 qts. per acre	excellent	3 days	12 hours	Highly toxic to predator mites. Not compatible with oil.
Warrior 1CS (lambda-cyhalothrin)	3A	foliar/canopy spray	2.5-5.1 fl. oz. per acre	excellent	21 days	24 hours	Highly toxic to predator mites.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

Oriental Fruit Moth

CATEGORY: Insect

SCIENTIFIC NAME: *Grapholita molesta*

ORDER: Lepidoptera

DAMAGE: Burrow into fruit



Ric Bessin, University of Kentucky

DESCRIPTION

Oriental fruit moth is a 1/4-inch-long, charcoal-colored moth with fine alternating bands of light and dark lines giving it a mottled appearance. Oriental fruit moth eggs are flat and oval, initially opaque and white in color but turning brownish-red as they mature. Larvae are pinkish-white with brown heads and 1/2 inch long when mature. Oriental fruit moth and codling moth larvae are similar, but oriental fruit moth larvae can be differentiated by a small hidden four-prong comb on the end of their abdomen. Fruit are damaged by larva that burrow into fruit, reducing appearance and quality. Apples may drop prematurely or become misshapen if they remain on trees. If fruit are not available, larvae burrow into branches, twigs, or succulent growing tips, resulting in dieback. Typically, the second and third generations of this insect cause the most damage. This insect can be more of a problem where peaches are grown in the same orchard.



IMPORTANCE

Moderate – Kentucky apple growers rank oriental fruit moth third in terms of management difficulty and importance of yield loss. Oriental fruit moth is present in all regions of Kentucky and causes damage to unprotected fruit. Each larva can ruin one fruit. The presence of oriental fruit damage can reduce the reputation of individual orchards where control is poor.

MANAGEMENT

Critical Timing of Management Practices

Adult moths first appear approximately at the time of bloom and can produce six to eight generations per season.

Monitoring

- Pheromone traps are utilized to determine the need and timing for insecticide sprays using established thresholds. Pheromone traps that use chemical lures to attract male moths should be in place just before bloom. An action threshold of seven moths per trap per week is used to determine need for insecticidal control.
- An online degree day model is used with biofix information to accurately time insecticide sprays.

Physical Methods

Bag (oriental or Clemson fruit bags) fruit beginning when fruit are 1/2 inch to 3/4 inch in diameter for protection against late infestations. Bags should be applied after fruit are thinned and approximately 1 day after fungicide/insecticide applications. Remove bags 2 weeks prior to harvest to permit fruit to color. Bagging can be labor-intensive and expensive. Typically fruit bags are only used in organic production and by small scale producers.

Biological Methods

Sex attractant dispensers can be used to disrupt mating of male and female oriental fruit moths. However, due to the annual cost of state registration and limited apple acreage, these technologies are not available in Kentucky.

Insecticides

Insecticide applications should coincide with monitoring/scouting. The first insecticide spray is usually applied during bloom or as late as petal fall to control the first generation of this insect. Subsequent sprays are made during first, second, and third cover to control the most damaging generations of oriental fruit moth.

Effects on Beneficials & Pollinators

Some sprays for oriental fruit moth may injure beneficial insects and pollinators. The first generation often appears during bloom, and management of this generation is important for suppression of future generations. Many insecticides used during bloom can have negative effects on pollinators.

ORIENTAL FRUIT MOTH

INSECTICIDES LABELED FOR MANAGEMENT OF ORIENTAL FRUIT MOTH ON APPLE.

Insecticide	IRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Altacor 35WDG (chlorantranilip- role)	28	foliar/canopy spray	2.5-4.5 oz. per acre	excellent	5 days	4 hours	Can be used during bloom due to compatibility with pollinators. Also controls codling moth. Slightly toxic to predator mites.
Assail 30SG (acetamiprid)	4A	foliar/canopy spray	5-8 oz. per acre	excellent	7 days	12 hours	Due to the shorter PHI, this product is often used later in the season. Slightly toxic to predator mites.
Avaunt 30WDG (indoxacarb)	22	foliar/canopy spray	5-6 oz. per acre	good	14 days	12 hours	As it will also control plum curculio and codling moth, this can be used for the early cover sprays where all three pests need control. Moderately toxic to predator mites.
Belay 2.13SC (clothianidin)	4A	foliar/canopy spray	6-12 fl. oz. per acre	unknown	7 days	12 hours	As it will also control plum curculio and codling moth, this can be used for the early cover sprays where all three pests need control. Moderately toxic to predator mites.
Delegate 25WG (spinetoram)	5	foliar/canopy spray	4.5-7 fl. oz. per acre	excellent	7 days	4 hours	Due to the shorter PHI, this product is often used later in the season. Moderately toxic to predator mites.
Entrust 2SC (spinosad)	5	foliar/canopy spray	6-10 fl. oz. per acre	fair	7 days	4 hours	OMRI approved. Slightly toxic to predator mites.
Entrust 80WP (spinosad)	5	foliar/canopy spray	2-3 oz. per acre	fair	7 days	4 hours	OMRI approved. Slightly toxic to predator mites.
Imidan 70W (phosmet)	1B	foliar/canopy spray	2.1-5.3 lbs. per acre	excellent	7 days	72 hours	Not as effective against oriental fruit moth as it was. Slightly toxic to predator mites.
Intrepid 2F (methoxy- fenozide)	18	foliar/canopy spray	12-16 fl. oz. per acre	good	14 days	4 hours	Often used mid-season when primarily lepidopteran pests are of concern. Slightly toxic to predator mites.
Rimon 0.83EC (novaluron)	15	foliar/canopy spray	20-40 fl. oz. per acre	good	14 days	12 hours	Slightly toxic to predator mites.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

Plum Curculio

CATEGORY: Insect

SCIENTIFIC NAME: *Conotrachelus nenuphar*

ORDER: Coleoptera

DAMAGE: Injure buds, flowers, and fruit



Ric Bessin, University of Kentucky

DESCRIPTION

Plum curculio adults are typical snout beetles. They are 1/4 inch long, dark brown with patches of white or gray, and have four prominent humps on wing covers. Larvae are legless, grayish white grubs with brown heads, and 1/3 inch long when full grown. Injury to fruit appears as a 1/8 inch crescent-shaped cut on fruit surfaces. These injuries are made by female adults during egg laying. Larvae burrow into fruit, which may result in premature fruit drop. Adults feed on buds, flowers, and newly set fruit, resulting in catfacing or fruit decay.

Ric Bessin, University of Kentucky



Ric Bessin, University of Kentucky



IMPORTANCE

Major – Kentucky apple growers ranked plum curculio second in terms of yield loss and fifth in terms of management difficulty. Plum curculio is present in all regions of Kentucky, causing damage to unprotected fruit. A single female may damage many fruit during egg laying. While most egg laying scars do not result in viable larva, cut surfaces develop into 2/5-inch scars on fruit surfaces at harvest. There is one generation of plum curculio per year in Kentucky.

MANAGEMENT

Critical Timing of Management Practices

Adult plum curculio becomes active in early spring. Management should begin at petal fall and continue through first cover, possibly extending to second cover.

Monitoring

- Check developing fruit regularly for signs of plum curculio activity. Most growers spray preventative insecticides and rarely scout for this pest
- Use beat sheets to monitor for adults.

Cultural Practices

Remove dropped fruit as it may harbor plum curculio. Larvae exit fallen fruit and burrow into the soil where they overwinter.



Ric Bessin, University of Kentucky

Biological Methods

There is a new lure to monitor for plum curculio, but it has not been evaluated in Kentucky.

Insecticides

Insecticide sprays should begin during petal fall and/or first cover spray or when the first signs of egg laying are observed.

Effects on Beneficials & Pollinators

Insecticides should be applied at petal fall through second cover. Rat-tailed blooms (or delayed bloom) may coincide with insecticide applications. This can increase the risk to pollinators.

INSECTICIDES LABELED FOR MANAGEMENT OF PLUM CURCULIO ON APPLE.

Insecticide	IRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Actara 25WDG (thiamthoxam)	4A	foliar/canopy spray	4.5-5.5 oz. per acre	good	14/35 days	12 hours	Moderately toxic to predator mites.
Assail 30SG (acetamiprid)	4A	foliar/canopy spray	8 oz. per acre	good	7 days	12 hours	Slightly toxic to predator mites.
Avaunt 30WDG (indoxacarb)	22	foliar/canopy spray	5-6 oz. per acre	good	14 days	12 hours	Moderately toxic to predator mites. In orchards where resistance to phosmet occurs, indoxacarb is commonly used when applied as cover sprays; it controls codling moth, oriental fruit moth, and plum curculio.
Belay 2.13SC (clothianidin)	4A	foliar/canopy spray	6 fl. oz. per acre	good	7 days	12 hours	Moderately toxic to predator mites.
Imidan 70WP (phosmet)	1B	foliar/canopy spray	2.1-5.3 lbs. per acre	good	7 days	72 hours	Slightly toxic to predator mites. Frequently used for early cover sprays as it controls codling moth, oriental fruit moth, and plum curculio. Some resistance by codling moth has been observed.
Surround (kaolin)		foliar/canopy spray	25-50 lbs. acre	fair	0 days	4 hours	OMRI approved. Moderately toxic to predator mites.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

Rosy Apple Aphid

CATEGORY: Insect

SCIENTIFIC NAME: *Dysaphis plantaginea*

ORDER: Hemiptera

DAMAGE: Leaf curling and fruit distortion



Ric Bessin, University of Kentucky

DESCRIPTION

Rosy apple aphids can be distinguished by their greenish-rose color. All stages of rosy apple aphid live together underneath leaves. Young aphids change from dark green to purple as they grow. Rosy apple aphid saliva contains a toxin that causes severe leaf curling and fruit distortion. Curled leaves must be unfurled in order to detect colonizing aphids. Eggs are laid on twigs, in bud axils, or in bark crevices. Individual eggs are 1/50 inch long, football-shaped, and black. Honeydew or sooty mold on leaves or fruit is a common indication of aphid presence.



A colony of aphids on a fruit spur can injure all developing apples and cause knobby, pigmy fruit on that spur. Aphid feeding can also result in stunted new growth. Earliest damage occurs soon after petal fall, but by mid-summer the aphids move to alternate hosts. While all apple cultivars are susceptible to rosy apple aphid, Cortland, Ida Red, and Golden Delicious are particularly susceptible.

IMPORTANCE

Moderate – Kentucky apple growers ranked aphids (in general) third in terms of yield loss. Rosy apple aphids are common throughout the state. They affect approximately 5% of apple acreage, but populations vary significantly from year to year.

MANAGEMENT

Critical Timing of Management Practices

Monitoring for aphids should begin early in the season. Even small infestations can cause damage, and populations can expand rapidly. Once leaves become tightly curled, management is difficult.

Monitoring

- Monitor for the presence of active aphid colonies on four leaf terminals on each of five scaffold limbs for each tree. Record the total number of aphid infestations per 20 leaf terminals or fruit clusters by species. Apply insecticide treatments when 5% of terminals are found to have rosy apple aphid infestations

Cultural Practices

Remove infested stems by hand.

Biological Methods

Predators aid in management of rosy apple aphid and other aphids during the early season.

Insecticides

Insecticides are generally applied between the half-inch green to tight cluster stages prior to bloom, or when infestations exceed 5% of terminals or fruit clusters. Sprays may continue throughout the season based on aphid pressure, as determined by scouting.

Effects on Beneficials & Pollinators

Many insecticides used for rosy apple aphid management have negative effects on predatory mites. Broad-spectrum products should not be used during bloom to protect pollinators.

INSECTICIDES LABELED FOR MANAGEMENT OF ROSY APPLE APHID ON APPLE.

Insecticide	IRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Actara 25WDG (thiamthoxam)	4A	foliar/canopy spray	4.5-5.5 oz. per acre	excellent	14/35 days	12 hours	Moderately toxic to predator mites.
Admire Pro 4.6EC (imidacloprid)	4A	foliar/canopy spray	1.4-2.8 fl. oz. per acre	excellent	7 days	12 hours	Moderately toxic to predator mites.
Assail 30SG (acetamiprid)	4A	foliar/canopy spray	2.5-4 oz. per acre	excellent	7 days	12 hours	Slightly toxic to predator mites.
Beleaf 50SG (flonicamid)	29	foliar/canopy spray	2-2.8 fl. oz. per acre		21 days	12 hours	
Centaur 70WDG (buprofezin)	16	foliar/canopy spray	34.5 oz. per acre	unknown	14 days	12 hours	Slightly toxic to predator mites.
Diazinon AG 600WBC (diazinon)	1B	foliar/canopy spray	see label for rates	fair	21 days	4 days	Slightly toxic to predator mites. See note ³
Esteem 35WP (pyriproxifen)	7C	foliar/canopy spray	4-5 oz. per acre (at half-inch green), 3-5 oz. per acre (at petal fall)	excellent	45 days	12 hours	Slightly toxic to predator mites. Also provides excellent control of San Jose scale when used at this time.
Lorsban Advanced 4E (chlorpyrifos)	1B	foliar/canopy spray	0.5-4 pts. per acre (at green tip), 1.5-4 pts. per acre (at pink)	good	varies	4 days	Moderately toxic to predator mites. Labeled only for use before petal fall. PHI varies for different formulations and application rates. See note ³
Lorsban 50W (chlorpyrifos)	1B	foliar/canopy spray	3 lbs. per acre	good	varies	4 days	Moderately toxic to predator mites. Labeled only for use before petal fall. PHI varies for different formulations and application rates. See note ³
Lorsban 75WG (chlorpyrifos)	1B	foliar/canopy spray	2-2.67 lbs. per acre	good	varies	4 days	Moderately toxic to predator mites. Labeled only for use before petal fall. PHI varies for different formulations and application rates. See note ³
Movento 2SC (spirotetramat)	23	foliar/canopy spray	6-9 fl. oz. per acre	good	7 days	24 hours	Toxic to honey bees and should only be used after petal fall.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³ Note: Often mixed with an oil

⁴Note: Do not use within 14 days of application of Captan, Sevin, or other sulfur-containing products.

INSECTICIDES LABELED FOR MANAGEMENT OF ROSY APPLE APHID ON APPLE. (CONT'D)

Insecticide	IRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Sivanto 200SL (flupyradifurone)	4D	foliar/canopy spray	7-10.5 fl. oz. per acre	good	14 days	4 hours	
Summer oils (horticultural oil)		foliar/canopy spray	1-2% per acre				Do not apply when temperatures exceed 90°F. Concentrations greater than 2% may affect fruit finish on some varieties. See note ⁴
Superior oil (horticultural oil)		foliar/canopy spray	2% per acre		varies	12 hours	Apply oil when temperature is about 40°F. Check label for fungicide/oil compatibility. Most effective when sprayed dilute under calm conditions. PHI varies for different formulations and application rates.
Supracide 2E (methidathion)	1B	foliar/canopy spray	8-12 pts. per acre	excellent	varies	72 hours	Moderately toxic to predator mites. PHI varies for different formulations and application rates. See note ³
Supracide 25WP (methidathion)	1B	foliar/canopy spray	4-12 lbs. per acre	excellent	varies	72 hours	Moderately toxic to predator mites. PHI varies for different formulations and application rates. See note ³

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³ Note: Often mixed with an oil

⁴Note: Do not use within 14 days of application of Captan, Sevin, or other sulfur-containing products.

San Jose Scale

CATEGORY: Insect

SCIENTIFIC NAME: *Quadraspidiotus perniciosus*

ORDER: Hemiptera

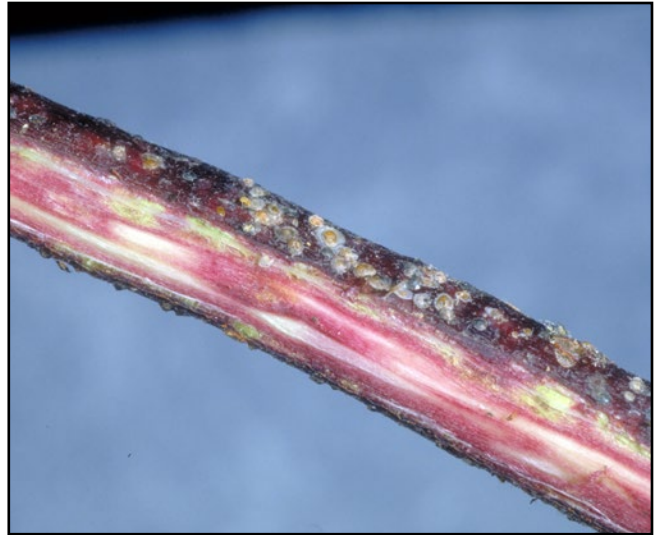
DAMAGE: Injure fruit, weaken tree limbs



Ric Bessin, University of Kentucky

DESCRIPTION

San Jose scale are small, 1/20 inch, flattened, gray, and circular with concentric rings and a tiny knob in the center. Immature scales (crawlers) are yellow, 1/200 inch long and only visible with a hand lens. They may resemble spider mites. San Jose scale saliva contains a toxin that causes red flecking on mature fruit and under bark of new growth. Severe infestations over time can lead to limb and tree death.



IMPORTANCE

Moderate – Kentucky apple growers ranked scale insects (in general) fourth in terms of management difficulty. San Jose scale is present at low levels in all orchards. Severe infestations can cause weakening and stunting. In extreme cases, limb or tree death can result.

MANAGEMENT

Critical Timing of Management Practices

Growers often notice active San Jose scale infestations while pruning during the dormant period. Monitoring for San Jose scale should begin in early spring. Management practices should be timed to control nymphs during the delayed-dormant period or when crawlers first appear, before these insects develop their protective waxy coating.

Monitoring

- Monitor scale activity while pruning during winter.
- Pheromone traps that use chemical lures to attract adult males should be distributed through the orchard beginning at apple pink stage. Once adult males are observed in pheromone traps, utilize a model that calculates degree days to determine when crawlers will emerge and thus, when insecticide sprays should be applied.
- Monitor for the presence of crawlers in mid-

May/mid-June by trapping with dark-colored, double sided sticky tape wrapped around scaffold limbs.

Cultural Practices

Prune and destroy severely damaged limbs.

Insecticides

Insecticide sprays should begin at apple green tip. If scale is not controlled during this period, then it should be managed at crawler emergence. The first crawlers are typically observed in mid-May or mid-June. Sprays should be applied 1 week after first crawlers are detected. Severe infestations require a second application 2 weeks later. Insecticides applied for San Jose scale during the delayed-dormant period also help manage aphids.

Effects on Beneficials & Pollinators

Some insecticides used for management of San Jose scale have negative effects on predatory mites. Products should not be used during bloom to protect pollinators.

INSECTICIDES LABELED FOR MANAGEMENT OF ROSY APPLE APHID ON APPLE.

Insecticide	IRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Admire Pro 4.6EC (imidacloprid)	4A	foliar/canopy spray	2.8 fl. oz. per acre	fair	7 days	12 hours	Moderately toxic to predator mites.
Assail 30SG (acetamiprid)	4A	foliar/canopy spray	8 oz. per acre	fair	7 days	12 hours	Slightly toxic to predator mites.
Centaur 70WDG (buprofezin)	16	foliar/canopy spray	34.5 oz. per acre	excellent	14 days	12 hours	Slightly toxic to predator mites.
Diazinon AG 600WBC (diazinon)	1B	foliar/canopy spray	see label for rates (at green tip), 12.75 fl. oz. per 100 gals. (at first or second cover)	good	21 days	4 days	Slightly toxic to predator mites.
Esteem 35WP (pyriproxyfen)	7C	foliar/canopy spray	4-5 oz. per acre	excellent	45 days	12 hours	Minimum rate is effective when used pre-bloom. Maximum rate is necessary if application is made for crawlers in early summer. Slightly toxic to predator mites.
Lorsban Advanced 4E (chlorpyrifos)	1B	foliar/canopy spray	0.5-4 pts. per acre	excellent	see note ³	4 day	Mix with oil. Moderately toxic to predator mites. Labeled only for use before petal fall.
Lorsban 50W (chlorpyrifos)	1B	foliar/canopy spray	3 lbs. per acre	excellent	see note ³	4 days	Mix with oil. Moderately toxic to predator mites. Labeled only for use before petal fall.
Lorsban 75WG (chlorpyrifos)	1B	foliar/canopy spray	2-2.67 lbs. per acre	excellent	see note ³	4 days	Mix with oil. Moderately toxic to predator mites. Labeled only for use before petal fall.
Movento 2SC (spirotetramat)	23	foliar/canopy spray	6-9 fl. oz. per acre	good	7 days	24 hours	
Sivanto 200SL (flupyradifurone)	4D	foliar/canopy spray	10.5-14 fl. oz. per acre	unknown	14 days	4 hours	

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³ Note: PHI varies for different formulations and application rates.

⁴Note: Do not use within 14 days of application of Captan, Sevin, or other sulfur-containing products.

INSECTICIDES LABELED FOR MANAGEMENT OF ROSY APPLE APHID ON APPLE. (CONT'D)

Insecticide	IRAC	Application Method	Rate	Efficacy Rating	PHI ¹	REI ²	Comments
Superior oil (horticultural oil)		foliar/canopy spray	2% per acre		see note ³	12 hours	Apply oil when temperature is about 40°F. Check label for fungicide/oil compatibility. Most effective when sprayed dilute under calm conditions. See note ⁴
Supracide 2E (methidathion)	1B	foliar/canopy spray	8-12 pts. per acre	excellent	see note ³	72 hours	Moderately toxic to predator mites.
Supracide 25WP (methidathion)	1B	foliar/canopy spray	4-12 lbs. per acre	excellent	see note ³	72 hours	Mix with oil. Moderately toxic to predator mites.

¹PHI = Pre-harvest interval

²REI = Re-entry interval

³Note: PHI varies for different formulations and application rates.

⁴Note: Do not use within 14 days of application of Captan, Sevin, or other sulfur-containing products.

Woolly Apple Aphid

CATEGORY: Insect

SCIENTIFIC NAME: *Eriosoma lanigerum*

ORDER: Hemiptera

DAMAGE: Injure roots and limbs, reduce tree growth and yield



Ric Bessin, University of Kentucky

DESCRIPTION

Woolly apple aphid colonies appear as cottony masses, generally clustered in wounds and leaf axils near tree centers aboveground and on roots below ground. The aphids are purple and surrounded by white, cottony, thread-like secretions. Honeydew or sooty mold on leaves or fruit are a common indication of aphid presence. Unlike other aphids, this sucking insect feeds on all above and below ground plant tissues. Woolly apple aphid causes tree weakening and stunting. Yields are reduced as a result of feeding on limbs and roots. Root feeding may result in short fibrous roots, gall formation, nutrient imbalance, or increased risk of fungal infection. Severe root infestations can stunt or kill young trees.



IMPORTANCE

Moderate – Kentucky apple growers rank aphids (in general) third in terms of importance to yield loss and management difficulty. Approximately one-third of Kentucky orchards are affected each season by the woolly apple aphid. Young or damaged trees are at a greater risk. Common rootstocks B9, M9, M26, and the P series are susceptible to woolly apple aphid infestation.

MANAGEMENT

Critical Timing of Management Practices

Monitoring for aphids should begin early in the season, as even small infestations can expand rapidly and cause damage. Likewise, management practices should be deployed early. Woolly apple aphid problems are common in years following a periodical cicada emergence. Wounds created by cicada egg laying can become colonized by woolly apple aphid.

Monitoring

Monitor for the presence of active aphid colonies by examining four pruning scars on each of five scaffold limbs per tree. Determine when colonies are active by removing the waxy residue that covers the colony. Treatments are recommended once 10% of pruning scars are infested with live colonies.

Cultural Practices

Select semi-resistant rootstocks, such as M111 and M106.

Biological Methods

Natural enemies include lady beetles, syrphid fly larvae, and lacewing larvae.

Insecticides

Due to the waxy residue produced by woolly apple aphids, chemical management is difficult. As a result, higher volume sprays are necessary. Insecticide sprays begin at apple green tip or half-inch green, or when infestation exceeds 10% of pruning scars. Sprays may continue throughout the season based on aphid pressure as determined by scouting. Insecticides labeled for management of woolly apple aphid are for aboveground infestations; no insecticides are known to control root infestations.

Effects on Beneficials & Pollinators

Many insecticides used for woolly apple aphid management have negative effects on predatory mites. Products should not be used during bloom to protect pollinators.

INSECTICIDES LABELED FOR MANAGEMENT OF WOOLLY APHID ON APPLE.

Insecticide	IRAC	Application Method	Rate	Efficacy Rating	PHI¹	REI²	Comments
Admire Pro 4.6EC (imidacloprid)	4A	foliar/canopy spray	7-10.5 fl. oz. per acre	good	7 days	12 hours	Moderately toxic to predator mites.
Beleaf 50SG (flonicamid)	29	foliar/canopy spray	2-2.8 fl. oz. per acre		21 days	12 hours	
Diazinon AG 600WBC (diazinon)	1B	foliar/canopy spray	see label for rates	good	21 days	4 days	Slightly toxic to predator mites.
Movento 2SC (spirotetramat)	23	foliar/canopy spray	6-9 fl. oz. per acre	good	7 days	24 hours	Toxic to honey bees and should only be used after petal fall.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

Infestation Periods

Infestation periods and critical times for insecticide/miticide applications in commercial orchards in Kentucky.

	Coddling Moth	Oriental Fruit Moth	Plum Curculio	Aphids	Mites	Scale	Plant Bugs, Stink Bugs
Dormant to Silver Tip							
Green Tip to Half Inch Green				+	+	+	
Tight Cluster				+		+	
Pink				+		+	+
Bloom						+	+
Petal Fall		+	+	+		+	+
First Cover		+	+	+		+	+
Second Cover	+	+	+	+		+	+
Third Cover	+	+			+	+	+
Summer Cover Sprays	+	+			+	+	+

Grower Survey Results

A survey of Kentucky growers resulted in the following rating of insect importance and management challenges.

Yield Loss/Importance		Management Difficulty	
1	Codling Moth	1	Codling Moth
2	Plum Curculio	2	Stink Bug
2	Stink Bug	3	Oriental Fruit Moth
3	Oriental Fruit Moth	3	Plum Curculio
3	Aphids/Rosy Apple Aphid	3	Aphids/Rosy Apple Aphid
4	Scale/San Jose Scale	3	Scale/San Jose Scale
4	Mites/European Red Mite	4	Mites/European Red Mite
5	Green June Bug	4	Green June Bug
5	Japanese Beetle	4	Japanese Beetle

Resources

- IPM Scouting Guide for Common Problems of Apple, University of Kentucky (ID-219)
<http://www2.ca.uky.edu/agcomm/pubs/ID/ID219/ID219.pdf>
- Midwest Fruit Pest Management Guide (ID-232)
<http://plantpathology.ca.uky.edu/files/id-232.pdf>
- Codling Moth (ENTFACT-203)
<https://entomology.ca.uky.edu/ef203>
- European Red Mite (ENTFACT-205)
<https://entomology.ca.uky.edu/ef205>
- Green Fruitworms (ENTFACT-214)
<https://entomology.ca.uky.edu/ef214>
- Leafhoppers on Apples (ENTFACT-215)
<https://entomology.ca.uky.edu/ef215>
- Oriental Fruit Moth (ENTFACT-212)
<https://entomology.ca.uky.edu/ef212>
- Plum Curculio (ENTFACT-202)
<https://entomology.ca.uky.edu/ef202>
- Rosy Apple Aphid (ENTFACT-211)
<https://entomology.ca.uky.edu/ef211>
- San Jose Scale (ENTFACT-204)
<https://entomology.ca.uky.edu/ef204>
- Woolly Apple Aphid (ENTFACT-219)
<https://entomology.ca.uky.edu/ef219>

Honeyvine Milkweed

CATEGORY: Weed

SCIENTIFIC NAME: *Cynanchum leave*

DAMAGE: Competes for water and nutrients



John strang, University of Kentucky

DESCRIPTION

Honeyvine milkweed is a vining perennial weed that has opposite, waxy, heart-shaped leaves 3 to 7 inches long, and white flower clusters within nodes. Foliage exudes a milky sap when cut or crushed. Honeyvine milkweed is difficult to control because of its large perennial taproot, rapid growth rate, large annual production of seeds, and minimal treatable surface. This weed grows rapidly through trees, making it difficult to manage with post-emergent herbicides.

Honeyvine milkweed is a problem in orchards when it interferes with orchard management (such as preventing thorough pesticide spray coverage). Weeds can also harbor pests that impact apple development.

IMPORTANCE

Minor – A survey of Kentucky apple growers indicated that honeyvine milkweed was of minor importance in terms of yield loss. This weed was also ranked as minor in terms of species that are difficult to manage, making it of less concern to growers.

Honeyvine milkweed is not common in orchards, and less than 5% of Kentucky acreage infested per growing season. Yield losses are considered minimal. Less than 5% of Kentucky orchard acreage is treated for this weed.

MANAGEMENT

Critical Timing of Management Practices

Control measures should be implemented at weed germination. This weed is difficult to control once the extensive root system become established.

Herbicides

Pre-emergent herbicides may provide partial suppression. Post-emergent herbicides provide moderate control, but regrowth from roots is typical. Except in heavy infestations, chemical control is equally as effective as mowing. Chemical controls suppress above-ground growth, but herbicides rarely provide complete control unless applied when weeds are young. Less than 5% of Kentucky orchards are treated for honeyvine milkweed.

Cultural Practices

Repeatedly cut above ground portions.

HERBICIDES LABELED FOR MANAGEMENT OF HONEYVINE MILKWEED IN APPLE ORCHARDS.

Herbicide	HRAC	Application Method	Formulation	Rate	PHI ¹	REI ²	Comments
Roundup WeatherMax (glyphosate)	G	spot treatment	liquid	11 oz. -3.3 qts. per acre	1 day	12 hours	1-2 applications per season

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

Johnsongrass

CATEGORY: Weed

SCIENTIFIC NAME: *Sorghum halepense*

DAMAGE: Competes for water and nutrients



John Strang, University of Kentucky

DESCRIPTION

Johnsongrass may reach a height of 3½ feet. Leaves are hairless and smooth and reach up to 24 inches long and 1/2 to 1 inch wide with white midribs down each leaf blade. Purple cone-shaped flower heads can reach a height of 3 to 8 feet. Johnsongrass reproduces by seeds and perennial rhizomes, making it difficult to control. This weed competes heavily with trees for nutrients and water. Johnsongrass is also a problem in orchards when it interferes with orchard management (such as preventing thorough pesticide spray coverage). Weeds can also harbor pests that impact apple development.



MANAGEMENT

Critical Timing of Management Practices

Johnsongrass should be managed at time of germination. Once it develops rhizomes, it is more difficult to manage.

Cultural Practices & Physical Methods

- Mow to slow growth of the johnsongrass stand.
- Avoid cultivation, which spreads rhizomes, making the problem worse.

Herbicides

Johnsongrass is a difficult weed to control when it becomes established as a perennial, therefore it is important to manage early. Use of pre-emergents is more effective than post-emergents. Grass-selective herbicides, such as sethoxydimpost (HRAC A), may also be beneficial for suppression of johnsongrass. Approximately 10% of Kentucky's apple acreage is treated.

IMPORTANCE

Major - Kentucky apple growers ranked Johnsongrass second in regards to yield loss, and in terms of management difficulty. It affects less than 20% of Kentucky apple acreage, and yield losses of 10% can occur when johnsongrass populations are high.

HERBICIDES LABELED FOR MANAGEMENT OF JOHNSONGRASS IN APPLE ORCHARDS.

Herbicide	HRAC	Application Method	Formulation	Rate	PHI ¹	REI ²	Comments
Karmex 80DF (diuron)	C2	banded application	dry flowable	4lbs. per acre		12-24 hours	One application per season.
Goal 2XL (oxyfluorfen)	E	banded application	liquid	2-6 pts. per acre		12-24 hours	One application per season.
Gramoxone Inteon 2L (paraquat)	D	banded application	liquid	2.5-4 pts. per acre		12-24 hours	One application per season. Restricted use chemical.
Poast 1.5EC (sethoxydim)	A	banded application	emulsifiable concentrate	1.5-2.5 pts. per acre	14 days	12-24 hours	One application per season.
Roundup WeatherMax (glyphosate)	G	banded application	liquid	11 oz. -3.3 qts. per acre		12 hours	One application per season.
Rely 280 (glufosinate)	H	banded application	liquid	48-82 oz. per acre	14 days	12 hours	One application per season.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

Marestail/Horseweed

CATEGORY: Weed

SCIENTIFIC NAME: *Conyza canadensis*

DAMAGE: Competes for water and nutrients



Robert Videki, Doronicum Kft, Bugwood.org

DESCRIPTION

Marestail is an annual weed that emerges as a basal rosette in autumn. In spring, the rosette grows upward to 6 feet tall. Leaves are alternate, linear, and simple with toothed margins. Mature plants have no petioles connecting leaves to stems. Stems are erect and unbranched. Seed that germinates through spring and early summer mature and set seed the same year, while seed that germinates in autumn overwinter in the rosette stage. Each plant may release 200,000 seeds that disperse easily by wind. Marestail is a problem in orchards when it interferes with orchard management (such as preventing thorough pesticide spray coverage), and it competes with trees for nutrients and water. Weeds can also harbor pests that impact apple development.

IMPORTANCE

Major – Kentucky apple growers rank marestalk as the most important weed species impacting yield loss, as well as the most difficult to manage. It is a common weed that may be present in 25% to 75% of Kentucky orchards during a growing season. Yield losses are estimated at 15%.

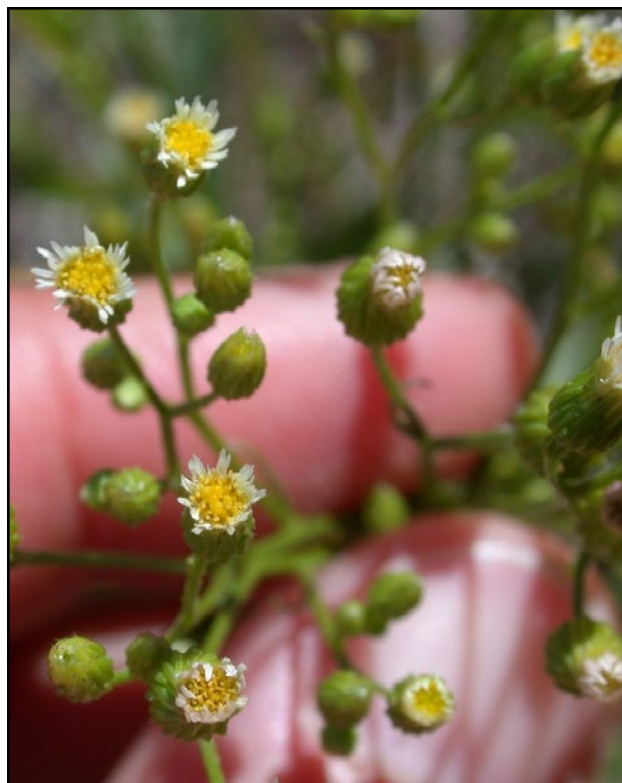
REGIONAL DIFFERENCES

Marestalk is more problematic in the midwestern grain-producing region, such as western Kentucky. Populations of marestalk are increasingly reported to have glyphosate resistance.

MANAGEMENT

Herbicides

Pre-emergent herbicides can be applied to minimize populations. Burn-down herbicides should be used during seedling or rosette stages. Marestalk biotypes resistant to acetolactate synthesis inhibitor herbicides (ALS) (HRAC B) and glyphosate (HRAC G) have been identified, so the use of these herbicides may be ineffective if resistances development occurs. Marestalk



Mary Ellen (Mel) Harte, Bugwood.org

is treated in approximately 50% of Kentucky orchard acreage.

HERBICIDES LABELED FOR MANAGEMENT OF MARESTAIL IN APPLE ORCHARDS.

Herbicide	HRAC	Application Method	Formulation	Rate	PHI ¹	REI ²	Comments
Karmex 80DF (diuron)	C2	banded application	dry flowable	4 lbs. per acre		12-24 hours	One application per season.
Gramoxone Inteon 2L (paraquat)	D	banded application	liquid	2.5-4 pts. per acre		12-24 hours	One application per season. Restricted use chemical.
Alion (indaziflam)	L	banded application	suspension concentrate	5-6 oz. per acre		12-24 hours	One application per season.
Chateau WDG (flumioxazin)	E	banded application	water dispersible granule	6-12 oz. per acre		12-24 hours	One application per season.
Rely 280 (glufosinate)	H	banded application	liquid	48-82 oz. per acre	14 days	12 hours	One application per season.
Treevix (saflufenacil)	E	banded application	water dispersible granule	1 oz. per acre		12-24 hours	One application per season.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

Palmer Amaranth

CATEGORY: Weed

SCIENTIFIC NAME: *Amaranthus palmeri*

DAMAGE: Competes for water and nutrients



Rebekah D Wallace, University of Georgia, Bugwood.org

DESCRIPTION

Palmer amaranth is one of many amaranth weeds common in Kentucky. Palmer amaranth leaves are ovate (egg-shaped) and are broader than leaves of other amaranths. Petioles of older leaves are as long as or longer than leaf blades, and leaves lack hairs. Palmer amaranth is a competitive invasive weed that is extremely adaptive. One plant can produce 100,000 to 500,000 seeds that may remain viable in soils for 5 years. Under ideal conditions, amaranth can set seed as early as 4 weeks after germination. Palmer amaranth is a problem in orchards when it interferes with orchard management (such as preventing thorough pesticide spray coverage), and it competes with trees for nutrients and water. Weeds can also harbor pests that impact apple development.

Bruce Ackley, Ohio State University, Bugwood.org



Rebekah D Wallace, University of Georgia, Bugwood.org

IMPORTANCE

Minor – A survey of Kentucky apple growers indicated that Palmer amaranth was of minor importance to yield loss and management difficulty, making it of less concern to growers. Currently, this weed is uncommon in Kentucky orchards, with less than 5% of acreage infested. However, this is an invasive weed and is expected to become problematic in the future.

MANAGEMENT

Critical Timing of Management Practices

Palmer amaranth has a high relative growth rate. It should be controlled soon after germination or it will quickly become too large to manage.

Herbicides

Apply herbicides before Palmer amaranth plants reach 4 inches in height. Combinations of pre- and post-planting herbicides should be applied for best results. Palmer amaranth resistance to acetolactate synthesis inhibitors (ALS) (HRAC B), 4-hydroxyphenylpyruvate dioxygenase (HPPD) (HRAC F) inhibitors, glyphosate (HRAC G), and dinitroaniline (HRAC K) herbicides has been documented. Less than 5% of Kentucky apple acreage is treated for this weed.

HERBICIDES LABELED FOR MANAGEMENT OF PALMER AMARANTH IN APPLE ORCHARDS.

Herbicide	HRAC	Application Method	Formulation	Rate	PHI ¹	REI ²	Comments
Casaron 4G (dichlobenil)	L	banded application	granular	100-150 lbs. per acre		12-24 hours	One application per season.
Chateau WDG (flumioxazin)	E	banded application	water dispersible granule	6-12 oz. per acre		12-24 hours	One application per season.
Gramoxone Inteon 2L (paraquat)	D	banded application	liquid	2.5-4 pts. per acre		12-24 hours	One application per season. Restricted use chemical.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

Grower Survey

A survey of Kentucky growers resulted in the following rating of weed importance and management challenges.

Yield Loss/Importance		Management Difficulty	
1	Marestail	1	Marestail
2	Johnsongrass	2	Johnsongrass
3	Vines (honeyvine milkweed, morning glory)	3	Vines (honeyvine milkweed, morning glory)
4	Foxtail	4	Foxtail
4	Thistle	4	Pennsylvania smartweed
5	Chickweed	4	Sedge
5	Henbit		
5	Palmer amaranth		
5	Pennsylvania smartweed		
5	Sedge		

Resources

- IPM Scouting Guide for Common Problems of Apple in Kentucky (ID-219)
<http://www2.ca.uky.edu/agcomm/pubs/ID/ID219/ID219.pdf>
- Midwest Fruit Pest Management Guide (ID-232)
<http://plantpathology.ca.uky.edu/files/id-232.pdf>

Beaver

CATEGORY: Wildlife

SCIENTIFIC NAME: *Castor canadensis*

DAMAGE: Physical injury to tree



Matt Springer, University of Kentucky

DESCRIPTION

The beaver is North America's and Kentucky's largest rodent. Adult beavers weigh between 35 and 60 pounds, with some reaching weights of 70 to 80 pounds. Adult beavers range in size from 25 to 31 inches from the tip of the nose to the base of the paddle-shaped tail. Beavers typically have large heads, indistinct necks, thick, stout bodies, and small ears and eyes.



Damage occurs when beavers chew into trunks, Beavers' most recognizable feature is a large, flat, hairless tail that is shaped like a paddle. This 6- to 8-inch wide and 10- to 12-inch long tail is used for support when the beaver is on land and as a steering, swimming, and communication device when it is in the water. Beavers have short, stout legs specialized for swimming and working. The large, fully webbed hind feet are adapted for swimming, whereas, the small front feet are dexterous, nimble, and not webbed. Beavers use their front feet for digging, as well as for holding and manipulating small twigs while they peel the bark off with their teeth.

Beavers have ears and nostrils with valves that close when it is submerged, eyes that are set high on the head to allow it to see above water when swimming, and lips located behind the front teeth that close when it is submerged, allowing it to use its teeth under water.

Like many other rodent species, beavers have a pair of continually growing, large, orange front teeth (incisors). It is almost impossible to tell the difference between male and female beavers unless the female is lactating and has swollen mammary glands.

gridling or cutting down entire trees for use in dams. Branches and tree trunks also serve as food. Beavers can remove bark around a tree when feeding, resulting in tree death.

IMPORTANCE

Minor - Beavers are common in Kentucky; however, they focus on trees located near their water sources. They do not travel far from these water bodies to feed or gather trees. Western Kentucky may have higher overall populations of beavers present in the region, particularly around the larger rivers.

MANAGEMENT

Cultural Practices & Physical Methods

- Trap and destroy the beavers present near orchards. This is the most effective way to manage populations.
- Wrap trees with 1/4- to 1/2-inch hardware cloth to a height of 4 feet.
- Manipulate pond water levels to remain at low levels in order to keep the area less suitable to beavers.
- Install fences around culverts, drains, and ponds to help keep water flowing and draining.
- Install electric fence around orchards, especially areas near water bodies.

Black Bear

CATEGORY: Wildlife

SCIENTIFIC NAME: *Ursus americanus*

DAMAGE: Physical injury

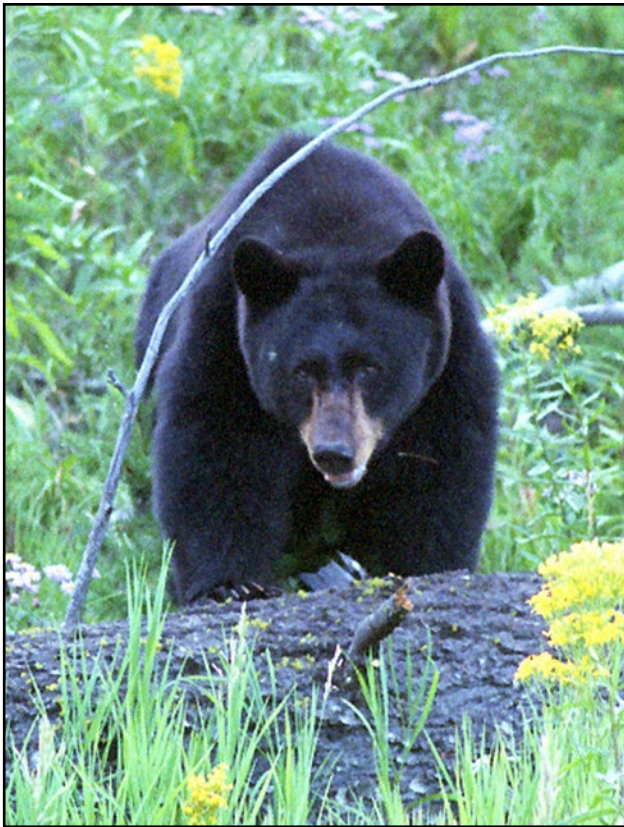


Dwight Wolfe, University of Kentucky

DESCRIPTION

Most black bears have a dark black coat; however, some variation is present and a more brownish color phase can occur. Male black bears commonly reach sizes exceeding 400 pounds, but females tend to be smaller (approximately 200 to 250 pounds). Black bear shoulder height is generally about 3 feet; however, they are adept at standing on their hind feet to obtain food or to examine their surroundings. When bears locate an orchard, they will aggressively consume fruit in autumn prior to going into

Terry Spivey, USDA Forest Service, Bugwood.org



hibernation. In addition, bears can be destructive for other reasons: they can damage trunks with their claws, and they are strong enough to break large branches or even entire adult trees.

Bears are talented climbers and will do so when startled or to obtain food. This ability makes standard tall woven wire fences ineffective in keeping bears out of orchards.

IMPORTANCE

Minor - Black bears are still relatively uncommon in Kentucky, but their range and population are growing. Individual bears can have extremely large home ranges and have been confirmed in both western and northern Kentucky. However, occurrences of individuals in those areas of the state are uncommon. The major concentration of the population is currently located in the southeastern counties of the state.

MANAGEMENT

Physical Methods

- Install electric fencing around orchards to eliminate the potential for damage.
- Use temporary scare devices, such as propane cannons, to frighten bears.
- If problems persist, contact Kentucky Department of Fish and Wildlife Resources for additional options.

Deer (White-tailed)

CATEGORY: Wildlife

SCIENTIFIC NAME: *Odocoileus virginianus*

DAMAGE: Physical injury



Dwight Wolfe, University of Kentucky

DESCRIPTION

The white-tailed deer is the smaller of the two ungulates in Kentucky. Adults exhibit a reddish brown summer coat and grayish brown fall and winter coat. Fawns (young) have rust-colored coats dotted with white spots. Males grow antlers from April through August, while females do not. Males can reach sizes of 250 pounds and females will generally weigh 100 to 150 pounds.



Matt Springer, University of Kentucky

Deer can cause problems in a number of ways:

- Deer feeding is characterized by tearing plants.
- Feeding on young shoots and foliage make training and development of proper tree structure difficult.
- Deer often rub their antlers on young flexible trees during mating season, causing trees to be destroyed in the process.
- The presence of deer in orchards during summer and autumn causes concerns regarding *E. coli* contamination of fruit.

IMPORTANCE

Major – Kentucky growers rank deer as the most important wildlife species in regards to yield loss and management difficulty. Deer are common throughout the state of Kentucky. However, deer densities vary widely across their range. Locally higher deer densities increase the likelihood of damage.

MANAGEMENT

Critical Timing of Management Practices

Protection of newly planted trees may be critical in high density areas. Enclosures for young trees may protect them during deer rut (mating season) in September, October, and November when deer are likely to rub their antlers on trees.

Cultural Practices & Physical Methods

- Localized hunting on or around orchards is the most effective method to reduce deer densities. Ensure that a large number of females are being harvested each year in order to reduce population levels.
- Install high welded wire fence around individual trees to protect them from browsing and antler rubbing.
- Install high-tensile electric fence or 10-foot tall woven wire fence around orchards.
- Install an off-set (double) fencing system. This design uses an outside fence that consists of two electrified wires less than 18 inches off the ground. A second 4-foot fence is 3 feet inside and is also electrified. Deer are unlikely to jump this fence because of their poor depth perception. The electrified lines also prevent deer from ducking under the wires to gain access to the orchard.

Repellents

Chemical area repellents or contact repellents can be used, but results are generally fair to poor.

Elk

CATEGORY: Wildlife

SCIENTIFIC NAME: *Cervus canadensis*

DAMAGE: Physical injury



John Strang, University of Kentucky

DESCRIPTION

Elk adult males can reach sizes over 750 pounds, while adult females reach 500 pounds. Elk height averages about 4 1/2 feet to their shoulders, and they are capable of jumping over 8-foot fences. Male elk grow large antlers each year and rub them against trees and other objects during the autumn mating season. The diet of elk is similar to deer; apples and apple trees are readily consumed.



Elk damage in orchards is similar to that of white-tailed deer; damage can occur in several ways:

- Elk feeding is characterized by tearing plants.
- Feeding on young shoots and foliage make training and development of proper tree structure difficult.
- Elk often rub their antlers on young flexible trees during mating season, causing trees to be destroyed in the process.
- The presence of elk in orchards during summer and autumn causes concerns regarding *E. coli* contamination of fruit.

IMPORTANCE

Minor to Major - Elk are generally a minor concern over most of the state; however, within their range, they are a major concern. Their current range is limited to the southeastern corner of the state; however, both their range and population are expanding. Elk are a reintroduced species to Kentucky and are the largest ungulate in the state.

MANAGEMENT

Critical Timing of Management Practices

Protection of newly planted trees may be critical in high density areas. Enclosures for young trees may protect them during the deer rut (mating season) in September, October, and November when deer are likely to rub their antlers on trees.

Cultural Practices & Physical Methods

- Manage elk populations by hunting during the elk season (permit required). Contact Kentucky Department of Fish and Wildlife Resources to learn more about the elk hunting land access program for hunters.
- Install high welded wire fence around individual trees to protect them from browsing and antler rubbing.
- Install high-tensile electric fence or 10-foot tall woven wire fence around orchards.
- Install an off-set (double) fencing system. This design uses an outside fence that consists of two electrified wires less than 18 inches off the ground. A second 4-foot fence is 3 feet inside and is also electrified. Deer are unlikely to jump this fence because of their poor depth perception. The electrified lines also prevent deer from ducking under the wires to gain access to the orchard.

Repellents

Chemical area repellents or contact repellents can be used, but results are generally fair to poor.

Rabbit (Cottontail)

CATEGORY: Wildlife

SCIENTIFIC NAME: *Sylvilagus floridanus*

DAMAGE: Physical injury



John Strang, University of Kentucky

DESCRIPTION

Rabbits weigh between 2 and 4 pounds and are 15 to 19 inches long. They are gray to brownish gray with a short tail and long ears. The underside of the tail is white and resembles a cotton ball. Rabbit feeding may girdle and kill trees. Injury typically occurs while trees are dormant and rabbit food sources are reduced.



IMPORTANCE

Minor - A survey of Kentucky apple growers indicated that rabbits were not a major concern for yield loss or management difficulty.

MANAGEMENT

Physical Methods

- Hunt or trap rabbits to help keep population numbers to a manageable level.
- Fence areas with woven wire fencing that is about 12 to 18 inches high with 6 inches turned outward and buried underground.
- Clean up fallen fruit in order to remove a food source that will attract rabbits.
- Keep areas beneath trees bare or relatively vegetation-free during winter to keep rabbits from inhabiting orchards.
- Maintain grassy areas and make sure there are no unmowed fence rows close to the orchard. This will eliminate overwinter cover and additional food sources.
- Protect young trees with hardware cloth to help reduce damage.

Repellents

Chemical repellents can be used, such as:

- Bone tar oil
- Thiram
- Fermented egg solids
- Ammonium soaps of fatty acids

Biological Methods

Install raptor perches to attract birds of prey.

Raccoon

CATEGORY: Wildlife

SCIENTIFIC NAME: *Procyon lotor*

DAMAGE: Feed on fruit



Gaby Muller, Wikimedia Commons

DESCRIPTION

Raccoons are an intermediate-sized mesopredator and omnivore that consumes a large selection of foods. They are grey and black in appearance with a long ringed tail and are known for the mask-like markings around their eyes. Raccoons average around 8 to 20 pounds in size. These animals are active through the entire apple growing and harvest seasons. Damage occurs when raccoons feed on fruit that are still attached to trees, as well as those that have fallen to the ground. Raccoons are very adept at using their “hands” to open containers, climb trees, and get into “protected” trash or stored foods. They are adaptable to human activity and development, taking advantage of any housing or food. Raccoons can vector several diseases, including rabies.



Gaby Muller, Wikimedia Commons

IMPORTANCE

Minor - Raccoons are common in Kentucky; however, apple growers consider them a minor pest.

MANAGEMENT

Physical Methods

- Hunt or trap raccoons for most effective management.
- Install electric fence around the orchard. Make sure there are no overhanging tree branches that offer an alternate route into the orchard.

Vole

(Pine vole, Prairie vole, Meadow vole)

CATEGORY: Wildlife

SCIENTIFIC NAMES: *Microtus pinetorum*, *Microtus ochrogaster*,
and *Microtus pennsylvanicus*

DAMAGE: Physical injury



John Strang, University of Kentucky

DESCRIPTION

Voles (often called meadow or field mice) are small compact mammals with stocky bodies, small rounded ears, short legs, and a short tail. When fully grown, voles are 4 to 5 inches long. Their long, coarse hair may be black, grizzled, or reddish. Voles have a high reproductive capacity, allowing populations to build rapidly. Tree injury results when voles eat bark from roots and lower tree trunks. Vole feeding damage occurs during winter and is particularly intense when there is a snow, weed, or mulch cover that protects voles from predators. Three different vole species damage and kill fruit trees in Kentucky.



IMPORTANCE

Minor - A survey of Kentucky apple growers indicated that voles were not a major concern for yield loss. However, there are reports of 50% to 100% loss in establishing orchards.

MANAGEMENT

Physical Methods

- Trap and remove voles; this is effective in smaller operations but may not be viable in larger orchards.
- Remove fallen fruit to eliminate vole food sources.
- Keep area beneath trees bare or relatively vegetation-free during winter. Maintain short grassy areas within and around the orchard to eliminate cover and additional food sources.
- Protect young tree trunks with hardware cloth.

Repellents & Baits

Chemical repellents or toxicants include:

- Bone tar oil
- Thiram
- Fermented egg solids
- Ammonium soaps of fatty acids

Baits or reodenticides include:

- Cholecalciferol
- Brodifacoum
- Bromadiolone
- Chlorophacinone
- Coumafuryl
- Zinc phosphide – a restricted-use rodenticide; place bait in runways or next to burrows. It is most effective when used during winter. Bait avoidance or shyness has been reported, so zinc phosphide should not be used more often than once every 6 months.

Biological Methods

Install raptor perches to attract birds of prey.

REPELLENTS AND RODENTICIDES LABELED FOR MANAGEMENT OF VOLES IN APPLE ORCHARDS.

Product	Application Method	Formulation (Type of Agent)	Rate	Comments
Ammonium soaps of fatty acids	repellent	Liquid	Up to 5.3 fl. oz. per gal. of water	Spray plants or apply more concentrated formulate (undiluted) to rags and leave in area surrounding crops.
Bone tar oil	repellent	Liquid	1 to 2 parts per 100 parts water	Saturate rags, cords, etc., and hang around field. Does not weather well. Requires frequent reapplication.
brodifacoum	rodenticide	Bait form (anticoagulant)		Use just prior to or during winter. Single day of feeding for lethality
bromadiolone	rodenticide	Bait form (anticoagulant)		Use just prior to or during winter. Single day of feeding for lethality
chlorophacinone	rodenticide	Bait form (anticoagulant)		Use just prior to or during winter. Multiple feedings needed for lethality.
cholecalciferol	rodenticide	Bait form (anticoagulant)		Use just prior to or during winter. Multiple feedings needed for lethality.
coumafuryl	rodenticide	Bait form (anticoagulant)		Use just prior to or during winter. Multiple feedings needed for lethality.
Deer Away (fermented egg solids)	repellent	Liquid	1 egg per cup of water	Spray or paint on plants and surrounding soil.
Defiant, Thiram, & others (thiram)	repellent	Liquid, dust, or granules	1 lb. to 6 qt. water	Cover vegetation thoroughly. Do not use on fruits to be consumed by humans.
zinc phosphide	rodenticide	Bait form		Use just prior to or during winter. Single day of feeding for lethality. Bait avoidance can occur; run 1 bait cycle every 6 months.

Yellow-bellied Sapsucker

CATEGORY: Wildlife

SCIENTIFIC NAME: *Sphyrapicus varius*

DAMAGE: Physical injury



John Strang, University of Kentucky

DESCRIPTION

Yellow-bellied sapsuckers are small woodpeckers with relatively short beaks. They have a black and white pattern over the majority of their bodies with the exception of the red crown (top of head). A distinctive white line along their wing fold and bold white patches on their wings helps to distinguish yellow-bellied sapsuckers from other similarly sized woodpeckers.

YELLOW-BELLIED SAPSUCKER

James Solomon, USDA Forest Service, Butwood.org



Yellow-bellied sapsucker injury is apparent as one or more rows of horizontal or vertical holes penetrating trunk bark. Injury usually occurs in spring on older trees when birds feed on inner tree bark, sap, and insects trapped in tree sap. Sapsuckers often revisit trees to feed on sap that collects in the holes they create.

IMPORTANCE

Moderate – Birds in general were ranked second by Kentucky apple growers in regards to yield loss and management difficulty. Growers did not rank sapsucker as specific pests of concern.

MANAGEMENT

Critical Timing of Management Practices

This is a migratory species that will only be present in Kentucky in autumn, winter, and early spring.

Physical Methods

- Utilize noise or visual frightening devices around orchards.
- Wrap trunks with screening.

Biological Methods

Install raptor perches to attract birds of prey.

Grower Survey

A survey of Kentucky growers resulted in the following rating of wildlife importance and management challenges.

Yield Loss/Importance		Management Difficulty	
1	Deer	1	Deer
2	Birds	2	Birds
3	Raccoons	3	Raccoons
4	Voles	4	Voles
4	Mice	4	Mice
		4	Rabbits

Resources

- IPM Scouting Guide for Common Problems of Apple in Kentucky (ID-219)
<http://www2.ca.uky.edu/agcomm/pubs/ID/ID219/ID219.pdf>
- Managing Beaver Problems in Kentucky (FOR-50)
<http://www2.ca.uky.edu/agcomm/pubs/for/for50/for50.htm>
- Managing Rabbit and Vole Problems in Kentucky Orchards (FOR-43)
<http://www2.ca.uky.edu/agcomm/pubs/for/for43/for43.htm>
- Managing White-Tailed Deer Problems in Kentucky (FOR-57)
<http://www2.ca.uky.edu/agcomm/pubs/for/for57/for57.htm>
- Wildlife Damage Management: Prevention, Problem Solving, & Conflict Resolution. 2013. R. F. Reidinger, Jr., and J. E. Miller. Johns Hopkins University Press, Baltimore, MD.

Bitter Pit

CATEGORY: Abiotic

CAUSE: Nutrient disorder

DAMAGE: Blemishes skin and flesh of fruit



John Strang, University of Kentucky

DESCRIPTION

Bitter pit is characterized by small dark pits concentrated around the calyx end of fruit. Symptoms may appear on fruit late in the season, but they generally develop in storage. This condition is caused by calcium deficiency in fruit and may also be associated with boron deficiency. Blemishes on fruit result in an unmarketable product. While bitter pit is similar to cork spot (both are due to calcium deficiencies), bitter pit is a storage problem, while cork spot occurs during the growing season.

IMPORTANCE

Moderate - Some cultivars are more susceptible to bitter pit than others. Approximately 4% of Kentucky acreage may be affected each growing season, with yield losses of approximately 4%.

MANAGEMENT

Critical Timing of Management Practices

- Adjust soil pH and calcium levels prior to planting; plow or till soil amendments as deeply as possible.
- Make foliar calcium applications at first cover spray to supply calcium to fruit skin.

Cultural Practices

- Consider cultivar susceptibility; some, such as Fuji, Golden Delicious, Honeycrisp, and Jonathan are more susceptible.
- Maintain soil pH between 6.0 and 6.5.
- Apply gypsum (calcium sulfate) to soils that have low calcium levels but do not require pH adjustment.
- Avoid excess nitrogen.
- Balance tree nutrition through regular tissue analysis to keep nitrogen, boron, potassium, magnesium, and zinc levels within the proper range.

- Promote optimal tree growth through nutrition and irrigation.
- Manage cropping levels. Lightly cropped trees result in large fruit and calcium deficiencies within fruit. In addition, lightly cropped trees generally have more vegetative growth, so calcium is moved to shoot tips and not into fruit.

Nutrients

Pre-harvest calcium sprays are necessary for cultivars that are particularly prone to this disorder. Begin sprays at first cover, and continue use in each subsequent cover spray until harvest. Harvested fruit can be dipped in calcium chloride or calcium prior to storage.

Chelated products are available to supply calcium to fruit, but studies have shown that calcium chloride is equally effective and much less expensive than chelated calcium products. Approximately 50% of Kentucky acres are treated for bitter pit.

NUTIRENTS LABELED FOR MANAGEMENT OF BITTER PIT ON APPLE.

Nutrient	Application Method	Rate	Comments
Calcium chloride	foliar/canopy spray	8 lbs. per acre or 1.5 to 2 lbs. per 100 gal.	6-15 applications per season depending on cultivar and season length. Applications should begin at first cover. Excessive application rates can result in foliage salt burn. Leaves become white when calcium chloride builds up.

Blackheart

CATEGORY: Abiotic

CAUSE: Environmental

DAMAGE: Damages woody tissues, resulting in tree decline



John Strang, University of Kentucky

DESCRIPTION

Blackheart results from freeze damage to xylem tissue. Xylem cells killed by freezing temperatures become filled with gummy occlusions and darken within the trunk. Tree decline and eventual death occurs if large amounts of tissue are killed or if wood decay fungi colonize dead tissue. Damage can occur when trees have not hardened-off properly in autumn, and during particularly cold winters less hardy cultivars and rootstocks are more susceptible to blackheart.



IMPORTANCE

Minor - Blackheart rarely occurs in Kentucky. Blackheart injury is more likely in the northern, central, and eastern mountain regions of Kentucky.

MANAGEMENT

Critical Timing of Management Practices

Pruning should begin in February after the coldest winter temperatures have passed. Younger trees, which are more susceptible to winter injury, should not be pruned until bud swell.

Cultural Methods

- Select apple cultivars that have a chilling requirement of at least 600 hours.
- Select rootstocks that are hardy in Kentucky.
- Avoid late season nitrogen applications.
- Avoid early winter pruning.

Boron Deficiency

CATEGORY: Abiotic

CAUSE: Nutrient disorder

DAMAGE: Blemishes skin and flesh of fruit



Mary Ann Hansen, VPI, Bugwood.org

DESCRIPTION

Boron deficiency is documented relatively frequently in Kentucky through apple foliar analyses, but symptoms are not as common because deficiencies are often at low levels. Symptoms first appear in fruit as an increase in corking and/or cracking. In more severe cases, fruit size is reduced and fruit may be malformed. Corking from boron and calcium deficiency symptoms are difficult to separate. Severe deficiency symptoms in high pH soils can include death of shoot tips, reduced leaf size, and rosette growth on terminal shoots. Blemishes on and in fruit result in unmarketable fresh fruit, but this level of deficiency is very rare in Kentucky.

IMPORTANCE

Minor - Thirty percent of Kentucky acreage may experience slight boron deficiency. Losses of 5% typically occur in conjunction with cork spot and bitter pit development. The Mississippi Plateau region of Kentucky is naturally deficient in boron. This includes Metcalfe, Cumberland, Russell, southern Adair, southern Pulaski, and Wayne counties. Meade county and the western coal fields surrounding Ohio, Muhlenberg, and McLean counties are also deficient.

MANAGEMENT

Critical Timing of Management Practices

One or two foliar boron applications should be made at pink, petal fall, or first cover.

Nutrient

Apply one or two foliar boron sprays during pink, petal fall, or first cover. Boron may also be applied between harvest and leaf drop if previous spray applications were not made.

While boron is necessary for optimum tree performance, the range between deficiency and toxicity is very small. Growers must make informed decisions based on nutrient test results. If too much boron is applied, toxicity can occur. There is no treatment for boron toxicity except to wait for rain to leach it from soils. Approximately 20% of Kentucky acres are treated with foliar boron

NUTRIENTS LABELED FOR MANAGEMENT OF BORON DEFICIENCY ON APPLE.

Nutrient	Application Method	Rate	Comments
Solubor	foliar/canopy spray	2 lbs. per acre	
Borax, Granubor 2	soil application	1-3 lbs. per acre	Do not exceed 3 lbs actual B or 27 lbs of Borax per acre. Broadcast (not banded) over the entire area. One application per season.
Sodium pentaborate	foliar/canopy spray		

Burr Knots

CATEGORY: Abiotic

CAUSE: Production problem

DAMAGE: Weakens trees



John Strang, University of Kentucky

DESCRIPTION

Burr knots are root initials that develop on aboveground portions of trees. These initials sometimes coalesce and girdle portions of trunks or limbs. Burr knots can provide a site for insect infestation (dogwood borers, plum borers, and woolly apple aphids), disease (fire blight and wood rot fungi), and winter injury. Large numbers of knots weaken trees, and resulting wood rot infections may girdle limbs. Development is favored by low light, high humidity, and warm temperatures.

John Strang, University of Kentucky



IMPORTANCE

Minor - Affected acreage is approximately 1%, with yield losses at 2%. This problem tends to be more common in the eastern Kentucky mountain region where trees remain wet for longer periods during the day.

MANAGEMENT

Cultural Practices

- Select rootstocks and cultivars that are less susceptible to burr knot. Cultivars, such as Lodi, and rootstocks, such as M7 and MM.111, are particularly susceptible to burr knot development.
- Select sites that dry more rapidly during the day, particularly those receiving morning sun.
- Avoid use of tree wraps, as these retain moisture and may promote burr knot development.

Chemical

Kentucky apple trees are not usually treated for burr knot.

ERADICANT LABELED FOR MANAGEMENT OF BURR KNOT ON APPLE.

Chemical	Application Method	Rate	Comments
Gallex	paint on	full strength	1-2 applications per year. Apply during dormancy, spring, or early summer; re-treat in 4-6 months if burr knot persists.

Cork Spot

CATEGORY: Abiotic

CAUSE: Nutrient disorder

DAMAGE: Blemishes skin and flesh of fruit



John Strang, University of Kentucky

DESCRIPTION

Cork spot, also known as York spot, begins as a slight depression on the fruit surface. It may also develop internally, causing the flesh to become dark and corky. Cork spot often appears during seasons when fruit are very large and calcium becomes diluted within fruit. Some cultivars, such as York and Honeycrisp, are more susceptible to cork spot. While cork spot is similar to bitter pit (both are due to calcium deficiencies), cork spot symptoms occur during the growing season, while bitter pit normally develops in storage.



IMPORTANCE

Moderate - Cork spot is found in most seasons on some cultivars and tends to be worse in light cropping years. Fifteen percent of Kentucky acreage may be affected, with yield losses approximately 10%.

MANAGEMENT

Critical Timing of Management Practices

Calcium uptake by fruit occurs during the first 30 days after bloom. Supplemental calcium should be applied beginning with the first or second cover spray.

Cultural Practices

- Maintain soil pH between 6.0 and 6.5.
- Avoid excess nitrogen application.
- Balance tree nutrition through regular tissue analysis to keep nitrogen, boron, potassium, magnesium, and zinc levels within the proper range.
- Moderate tree growth through nutrition and irrigation.
- Manage cropping levels. Lightly cropped trees result in large fruit and calcium deficiencies within fruit. In addition, lightly cropped trees generally have more vegetative growth, so calcium is moved to shoot tips for growth and not into fruit.

Nutrient

Calcium chloride is the least expensive and most frequently used calcium spray. Over-application of calcium can lead to foliar injury. Residue may be difficult to remove from fruit prior to marketing, particularly in the stem cavity. Six to 15 applications per season are often required, depending upon variety and harvest date.

Frost Injury

CATEGORY: Abiotic

CAUSE: Environmental

DAMAGE: Damages blossoms and developing fruit



John Strang, University of Kentucky

DESCRIPTION

Frost injury can affect flowers or small fruit. Injury to flower ovaries occurs when temperatures drop below critical levels during bloom. Browning occurs as soon as flowers thaw, and fruit/flowers drop from trees prematurely. If frost occurs after bloom, rings develop on fruit when ice forms beneath the fruit epidermis, separating the epidermis from fruit flesh and resulting in russetting. Frost rings typically occur at the calyx end of fruit. "Pumpkin fruit," in which fruit appear to have sutures, is another manifestation of severe cold injury to outer portions of fruit. Marketability of affected fruit depend on degree of injury and consumer tolerance.

Nicole Ward Gauthier, University of Kentucky



John Strang, University of Kentucky

IMPORTANCE

Major - Most Kentucky apple orchards experience some level of flower or fruit loss in at least 40 % of the spring seasons. During any given year, affected acreages can range from 0% to 90%. Yield losses may vary between 10% and 90%. Frost injury tends to be greater in the eastern mountain regions of Kentucky where spring frosts are more likely.

MANAGEMENT

Critical Timing of Management Practices

When temperatures are predicted to drop below freezing, measures to reduce orchard freezing should be executed. Early blooming cultivars are more susceptible to frost injury.

Cultural Practices

- Choose a growing site where cold air can flow away from orchards (air drainage).
- Select northern or eastern facing slopes that warm slower in the spring, delaying bloom development.
- Plant later-blooming cultivars.
- Elevate orchard temperature using wind machines or helicopters to pull warm air downward into the orchard from an overhead temperature inversion, or by using a supplemental heat source. Overhead sprinkling releases the heat of fusion from water, keeping buds, flowers, or fruit from freezing, if wind speed is low and evaporative cooling is not excessive.

Fruit Cracking, Stem-end Splitting & Internal Ring Cracking

CATEGORY: Abiotic

CAUSE: Physiological disorder

DAMAGE: Damages fruit

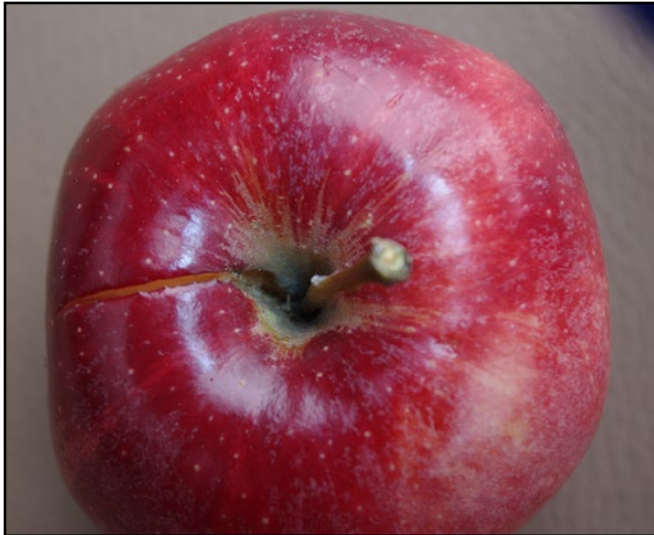


John Strang, University of Kentucky

DESCRIPTION

Fruit cracking, stem-end splitting, and internal ring cracking are caused by rapid fruit expansion. This can occur following excess rainfall or irrigation, particularly after a dry period. Internal ring cracking is a concentric crack found internally at the stem base. Severely damaged fruit cannot be sold for fresh market and are usually sold for cider.

John Strang, University of Kentucky



John Strang, University of Kentucky

IMPORTANCE

Moderate - Fewer than 5% of Kentucky acreage is affected by cracking/splitting. These disorders may occur between 0% and 90% of the time, depending on season and time of harvest. Yield losses attributed to fruit cracking range from 0% to 20%.

- Consider cultivar susceptibility; Stayman Winesap is susceptible to fruit cracking, and Gala and Fuji are susceptible to stem-end splitting and internal ring cracking.

Alternate Management Practices

Select new strains of Winesap that are less susceptible to cracking than Stayman Winesap.

MANAGEMENT

Cultural Practices

- Harvest fruit promptly when they are mature or show the first sign of cracking.
- Irrigate frequently to avoid extreme variations in soil moisture levels.

Growth Regulator

Growth regulator may be applied beginning in mid-June or mid-July, 2 to 3 weeks before cracking typically begins.

GROWTH REGULATOR LABELED FOR MANAGEMENT OF FRUIT CRACKING ON APPLE.

Growth Regulator	Application Method	Rate	REI ¹	Comments
ProVide 10SG	foliar/canopy spray	200 grams per 100 gal.	4 hours	3-6 applications per season. Applications begin from mid-June to mid-July 2-3 weeks before cracking typically begins.

¹ REI = Re-entry interval

Graft Union Breakage

CATEGORY: Abiotic

CAUSE: Production Problem

DAMAGE: Breakage at graft union



John Strang, University of Kentucky

DESCRIPTION

Graft union breakage is common on dwarf apple trees if adequate support is not provided. Dwarf tree graft unions are brittle and susceptible to breakage. As fruit develops, the increased weight places additional stress on the graft.

IMPORTANCE

Minor - Graft union breakage may occur on approximately 2% of dwarf trees, with 0.5% tree losses attributed to this problem.

MANAGEMENT

Critical Timing of Management Practices

It is important to stake or support trees shortly after planting.

Cultural Practices & Physical Methods

Support dwarf trees with a trellis or post.

Alternative Management Practices

Select semi-dwarf rootstocks that have a strong graft union.

Herbicide Injury: 2,4-D

CATEGORY: Abiotic

CAUSE: Herbicide (2,4 dichlorophenoxyacetic acid)

DAMAGE: Distortion of plant tissues, plant death



John Strang, University of Kentucky

DESCRIPTION

Leaf twisting, malformation, and curling are common symptoms of 2,4-D herbicide exposure. Symptoms may result from exposure from spray drift, volatilization, or sprayer contamination. Spraying 2,4-D under dry, low humidity conditions and at temperatures above 85°F, or use of ester formulations of this product, can lead to greater risk of volatilization and movement from the application area. Plant death may occur shortly after exposure or the following growing season. Damage can be more severe if exposure occurs later in the season.

IMPORTANCE

Minor - Damage occurs occasionally, depending on weather, season, and exposure. Yield losses are variable and are affected by temperature, wind direction, and distance from the target area. Often drift only causes some leaf epinasty and does not affect yield. Occasional heavy exposure may lead to total crop loss due to herbicide residues on fruit or from serious tree injury. This problem is more prevalent in western Kentucky areas where 2,4-D is used for weed management in row crops. Approximately 2% of Kentucky acreage may be affected each growing season.

MANAGEMENT

Cultural Practices

- Follow label directions when using 2,4-D. The less volatile amine formulation is labeled for broadleaf weed control in apple orchards.
- Avoid applications when temperatures are above 85°F.
- Use a coarse spray at low spray pressure to avoid volatilization and drift.
- Monitor 2,4-D use on nearby sites and farms.
- Maintain tree health through proper watering and fertilization if exposure occurs.

Herbicide Injury: Clomazone

CATEGORY: Abiotic

CAUSE: Herbicide (clomazone)

DAMAGE: Bleaches leaves



John Strang, University of Kentucky

DESCRIPTION

Clomazone is a volatile pre-emergence herbicide used on vegetable crops and soybeans. Contact from small amounts of this herbicide through drift or volatilization can bleach young leaves.

IMPORTANCE

Minor - Damage rarely occurs, perhaps affecting 0.5% of acreage in a growing season. No yield losses have been attributed to this herbicide.

MANAGEMENT

Cultural Practices

Irrigate and fertilize affected trees as needed to maintain tree health.

Herbicide Injury: Glyphosate

CATEGORY: Abiotic

CAUSE: Herbicide (glyphosate)

DAMAGE: Distortion of plant tissue, plant death



Mark Longstroff, Michigan State University

DESCRIPTION

Glyphosate exposure can occur anytime during the season. Early and mid-season symptoms can include distortion, interveinal chlorosis, short internodes, and circular chlorotic spots. Late-season exposure often becomes evident the following spring. Young trees are particularly susceptible to injury because their thin bark easily absorbs herbicides, and their lack of root carbohydrate reserves makes them less tolerant of exposure. Glyphosate also interferes with the development of cold hardiness, leading to winter injury and trunk cracking. Tree survival depends on the health of the tree at the time of exposure. Trees already weakened by other factors are more likely to die from glyphosate exposure.



Glyphosate moves downward from leaves through the vascular system to branches, trunk, and roots. Symptoms often occur shortly after tree exposure in spring and early summer. Late summer and autumn glyphosate exposure, however, can result in few or no immediate symptoms. The following growing season, glyphosate moves upward to foliage and symptoms occur in spring. These emerging leaves are often small, strap-like (narrow), and yellow-green in color. This overwintering cycle may be repeated for several years, resulting in recurring symptoms. Damage may be found on one or several limbs or over the entire tree depending on portions of the tree that were exposed.

The surfactant in some formulations enables glyphosate to penetrate trees more effectively than surfactants used in other glyphosate materials. Trees severely injured by these formulations typically do not produce buds in spring, or spring growth may be weak and collapse.

IMPORTANCE

Minor - Many orchards in Kentucky use glyphosate, so damage from drift within orchards is highly likely if growers use this herbicide. Western Kentucky orchards are more likely to be injured by glyphosate drift from outside the orchard because it is extensively used for weed management in row crops. Five percent of Kentucky acreage may be affected by glyphosate damage per growing season.

MANAGEMENT

Cultural Practices & Physical Methods

- Avoid glyphosate contact with bark or foliage.
- Minimize drift by using shielded sprayers, applying low pressure sprays, adding drift inhibitors, and making applications on calm days when temperatures are below 85°F.
- Employ alternatives to glyphosate for weed management:
 - Use pre-emergent herbicides to reduce the need to control weeds with post-emergent herbicides.
 - Use alternative post-emergent herbicides.
 - Use organic mulches to manage weeds beneath trees.
 - Use landscape fabric beneath apple trees.
 - Cultivate beneath trees.
 - Mow beneath trees.

Iron Deficiency

CATEGORY: Abiotic

CAUSE: Nutrient disorder

DAMAGE: Leaves become chlorotic



John Strang, University of Kentucky

DESCRIPTION

Iron deficiency symptoms first develop on the youngest leaves, which turn yellow (chlorotic). Initially the fine leaf veins remain dark green, but as the deficiency progresses, entire leaves turn uniformly yellow. This deficiency occurs when soil pH is above 7.0, and iron is chemically bound in soil and becomes unavailable to trees.

IMPORTANCE

Minor - Iron deficiency rarely occurs in Kentucky. Affected acreage is estimated at 0.2%.

MANAGEMENT

Cultural Practices

Lower soil pH (6.5 to 6.8) prior to planing for long-term management. It is much more difficult to lower soil pH once trees are planted.

Nutrient

Reducing soil pH with sulfur or acidifying nitrogen fertilizers takes several years. The use of an iron chelate provides more rapid, but temporary, results. Chelates provide a source of iron, but do not lower soil pH to make iron more available over the long-term. Iron chelate is applied to approximately 0.1% of Kentucky apple acres.

NUTRIENT LABELED FOR MANAGEMENT OF IRON DEFICIENCY ON APPLE.

Nutrient	Application Method	Comments
Tracite Iron 5%	foliar/canopy spray	Apply in enough water to thoroughly cover foliage. 1-2 applications per season. Apply when new foliage is being produced. Avoid high application rates as foliage can be injured.

Magnesium Deficiency

CATEGORY: Abiotic

CAUSE: Nutrient disorder

DAMAGE: Leaf blotching and leaf drop



Mosbah Kushad, University of Illinois

DESCRIPTION

Magnesium deficiency symptoms typically appear as light green blotches between veins on older leaves, progressing toward leaf margins. Blotches turn tan and then brown in color. Highly deficient leaves drop from trees. Magnesium deficiency causes weak growth, and small flowers and spurs. Excess magnesium in the soil decreases tree potassium and calcium uptake, which leads to deficiencies in these elements and promotes bitter pit. As tree potassium content increases, potassium to magnesium leaf ratios that reach or exceed 4:1 induce magnesium deficiency. This can occur even when leaf analysis shows magnesium to be sufficient.

IMPORTANCE

Minor - Magnesium deficiency rarely occurs and may affect 1% of Kentucky acreage. No yield losses have been attributed to this disorder.

MANAGEMENT

Cultural Practices

- Apply dolomitic limestone prior to planting if a soil pH increase is needed or soil test indicates a magnesium deficiency. Alternately, Epsom salt, magnesium oxide, or magnesium chelate may be tilled in prior to planting.
- Monitor tree magnesium levels through foliar analysis.

Nutrient

Foliar sprays used to correct magnesium deficiency are a temporary solution and the ultimate goal is to adjust soil magnesium levels. Applications can be made any time during the growing season. Approximately 20% of Kentucky apple acres are treated for magnesium deficiency with soil applications.

NUTRIENTS LABELED FOR MANAGEMENT OF MAGNESIUM DEFICIENCY ON APPLE.

Nutrients	Application Method	Rate	Comments
Dolomitic limestone	soil application	based on soil test & K/Mg ratio (soil application)	
Magnesium sulfate (Epsom salt)	soil or foliar application	15 lb/100 gal (foliar spray) or based on soil test & K/Mg ratio (soil application)	Applications made with a surfactant foliar spray should be applied at 10-15 day intervals beginning at petal fall. To avoid foliar damage, do not apply Epsom salts when temperatures are high and drying conditions are slow.
Magnesium chelate	soil application		Chelated magnesium has a lower magnesium content and is not effective as a foliar spray.
Magnesium oxide	soil application	based on soil test & K/Mg ratio (soil application)	

Manganese Bark Necrosis

CATEGORY: Abiotic

CAUSE: Nutrient disorder

DAMAGE: Slows tree growth



John Strang, University of Kentucky

DESCRIPTION

Manganese bark necrosis (measles) is manifested as an uneven bark surface with purplish raised pimples and dark deposits below bark. Manganese bark necrosis slows tree growth. It is caused by an excessive uptake of manganese from soil. Soil pH below 5 makes manganese more readily available and can lead to build-up of manganese beneath bark.

IMPORTANCE

Minor - Symptoms of manganese bark necrosis appear to be limited to Red Delicious. However, because this cultivar is not planted as often in Kentucky, manganese bark necrosis rarely occurs. There have not been reported yield losses attributed this disorder. Manganese bark necrosis is found occasionally in eastern Kentucky where soil pH levels are often low.

MANAGEMENT

Cultural Practices

- Maintain soil pH at the optimum level (6.0 to 6.5) as a preventative measure.
- Apply lime prior to planting if soil pH is low.
- Apply lime to established orchards when soil pH drops to 6.0.
- Improve soil drainage.

Necrotic Leaf Blotch

CATEGORY: Abiotic

CAUSE: Physiological

DAMAGE: Leaf blotching and leaf drop



Mohammad Babadoost, University of Illinois

DESCRIPTION

Necrotic leaf blotch is an abiotic disorder restricted to the cultivar Golden Delicious. It affects only mature leaves and is characterized by the development of irregular necrotic spots that usually appear within a 24-hour period. Most affected leaves turn yellow and drop within 4 to 7 days. Necrotic leaf blotch is associated with a cycle of several days of cool, wet, cloudy weather followed by sunny hot days.



IMPORTANCE

Moderate - Necrotic leaf blotch is restricted to the cultivar Golden Delicious and its progeny, such as Jonagold. It frequently occurs during cloudy seasons. Zero to 20% of Kentucky acreage may be affected each growing season. Fruit size can be reduced by 10% as a result of necrotic leaf blotch.

MANAGEMENT

Fungicide

While necrotic leaf blotch is a physiological disorder, research shows that fungicides and/or zinc may reduce leaf blotch levels, possibly by altering leaf physiology or phyllosphere microorganisms. Applications of fungicides should begin a month after petal fall and continue until the labeled pre-harvest interval (PHI).

NECROTIC LEAF BLOTCH

FUNGICIDES LABELED FOR MANAGEMENT OF NECROTIC LEAF BLOTCH ON APPLE.

Fungicide	FRAC	Application Method	Rate	Efficacy Rating	PHI¹	REI²	Comments
Dithane M-45, F-45 (mancozeb)	M	foliar/canopy spray	3 lbs. per acre	excellent	77 days		Do not apply more than 24 lbs. per acre per year. See note ³
Manzate Flowable, Flowable T&O, Max, Pro-Stick, Pro-Stick T&O (mancozeb)	M	ground application	3-6 lbs. per acre	excellent	77 days	24 hours	See note ³ and note ⁴
Penncozeb 75DF, 80WP (mancozeb)	M	ground application	3-6 lbs. per acre	excellent	77 days	24 hours	See note ³ and note ⁴
Ziram 76DF (ziram)	M	ground application	6 lbs. per acre	excellent	14 days	48 hours	Maximum of 7 applications per season. See note ³
Zinc oxide		foliar/canopy spray					Applications are made every 14 days from bloom to harvest.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

³ Note: Applications begin a month after petal fall and continue until PHI.

⁴ Note: Make 4 to 7 applications per season depending on rate and variety harvest date.

Poor Pollination

CATEGORY: Abiotic

CAUSE: Production problem; environmental

DAMAGE: Failure to set fruit; undersized fruit



John Strang, University of Kentucky

DESCRIPTION

Poor pollination can occur when there are insufficient numbers of pollinators visiting apple blossoms. This may be caused by too few beehives in the vicinity of the orchard and/or reduced bee flight. Bees fail to pollinate when weather is cold, windy, and wet during bloom. Hives located in sites that do not warm early in the morning also reduce bee flight. Frost or freeze injury may prevent pollination by damaging stigmas or killing fruit ovaries.

Snowball blooms (or large numbers of weak flowers) may not be easily pollinated, and therefore, may not set fruit.

Poorly pollinated fruit have insufficient numbers of developed seeds. Normally, fruit have ten fully developed seeds. These are important for production of large fruit because they mobilize carbohydrates into fruit during growth. Fruit with low seed numbers are typically smaller in size and may be asymmetrical or lopsided. Flowers that are not pollinated dry up and fail to set fruit.

IMPORTANCE

Moderate - Losses from poor pollination varies from year to year depending on spring weather conditions. Weather conditions conducive to poor pollination are common in eastern Kentucky where spring weather may be cooler or windier than other areas of the state. Acres affected can range from 0% to 100% with losses from 5% to 100%.

MANAGEMENT

Cultural

- Provide adequate honey bee numbers, particularly during cool, wet seasons.
- Avoid using insecticides during bloom.
- Provide supplemental heat to orchards on cold nights. Use of a small number of heaters, in combination with wind machines or overhead sprinkling, may protect flower stigmas.
- Thin fruit to remove those with low seed numbers and to assure a good return bloom the following season.

Chemicals

Begin thinning 5 weeks after bloom, with additional treatments at 7 and 9 weeks after bloom. Low concentrations of NAA can enhance bloom the following year on cultivars particularly susceptible to biennial bearing. Approximately 80% of Kentucky commercial orchards are treated with thinning agents to thin apple crops. About 1% of Kentucky acreage is treated with multiple applications of thinning compounds to encourage more bloom the following season.

CHEMICALS LABELED FOR MANAGEMENT OF POOR POLLINATION ON APPLE.

Chemical	Application Method	Rate	PHI ¹	REI ²	Comments
Fruitone L,N	foliar/canopy application	5 ppm NAA ³	5 days	24 hours	3 applications per season.
ProMaxa	foliar/canopy application	5 ppm NAA ³	5 days	24 hours	3 applications per season.

¹ PHI = Pre-harvest interval

² REI = Re-entry interval

Russeting

CATEGORY: Abiotic

CAUSE: Physiological

DAMAGE: Blemishes skin



John Strang, University of Kentucky

DESCRIPTION

Russeting is a wound healing response associated with frost injury or with rain, high humidity, or fluctuations in temperature occurring during early fruit development. Some fungicide or insecticide sprays can also injure fruit when not properly applied. Russeting is only associated with the fruit epidermis and does not extend into fruit flesh. It is a cosmetic problem and reduces marketability. The cultivar Golden Delicious is particularly susceptible to russeting.

IMPORTANCE

Moderate - Russeting occurs every year and may affect 5% of Kentucky acreage each growing season. The cultivar Golden Delicious is particularly susceptible. Severely russeted fruit may be used for cider production, but often the slightly to moderately russeted fruit are marketable. Russeting tends to be slightly worse in the eastern mountain region of Kentucky because fruit tend to dry off more slowly if mountains obstruct morning sun and humidity is high.

- Increase tree spacing to improve air movement.
- Prune annually to open tree canopy.
- Consider cultivar susceptibility; some cultivars or strains are prone to russeting, such as Golden Delicious.
- Avoid use of copper after quarter green leaf stage, particularly when temperatures are cool and drying conditions are slow, that can cause russet.

MANAGEMENT

Cultural Practices & Physical Methods

- Select elevated sites that dry out earlier in the morning and are less prone to frost. See also the frost injury section (pages 136-137).

Growth Regulator

Materials used to reduce fruit russeting may not be worth the cost of application since Kentucky growers are able to sell most russeted apples. Fruit, including Golden Delicious, are rarely treated in Kentucky for russeting.

GROWTH REGULATORS LABELED FOR MANAGEMENT OF RUSSETING ON APPLE.

Growth Regulator	Application Method	Rate	REI ¹	Comments
ProVide 10SG	foliar/canopy spray	60-100 grams per 100 gal. per acre	4 hours	2-4 applications per year. Begin applications at petal fall. Apply at 7-10 day intervals

¹REI = Re-entry interval

Sunburn Injury to Fruit

CATEGORY: Abiotic

CAUSE: Environmental

DAMAGE: Damages fruit



John Strang, University of Kentucky

DESCRIPTION

Sunburn injury to fruit is often associated with high temperatures, intense sunlight, and clear skies. It may occur when the weight of fruit results in a branch adjustment and previously protected fruit suddenly become exposed to direct sunlight. Sunburn frequently occurs on the southwest side of trees of light-skinned cultivars. It generally occurs when trees are under water stress, sunlight is intense, and there is no breeze to cool fruit. Sunburn occurs when fruit skin temperatures exceed 113°F. Severely damaged fruit cannot be sold for fresh market and are often used for cider or juice.

IMPORTANCE

Minor - Sunscald appears during summers in which light intensity and air temperatures are high. In some years, 5% of fruit are severely sunburned. Affected acreages can range from 0% to 20%.

- Consider cultivar susceptibility; certain cultivars are light-sensitive, such as Granny Smith, Gala, and Golden Delicious, and are more likely to become sunburned.
- Irrigate to prevent water stress.
- Protect harvested fruit from direct sunlight exposure.

MANAGEMENT

Cultural Practices & Physical Methods

- Follow proper tree pruning and training practices.
- Avoid excess summer pruning.
- Improve air movement through orchard.

Protectant

Fruit can be sprayed with a protectant coating; fruit should be washed and brushed to remove the protectant after harvest. Sunburn protectants are not used in Kentucky at this time. These may be considered on more susceptible cultivars.

PROTECTANTS LABELED FOR MANAGEMENT OF SUNSCALD ON APPLE FRUIT.

Protectant	Application Method	Rate	Comments
Raynox, Raynox Plus	foliar/canopy spray	2.5 gal. per acre	2-3 applications per season. Applications begin 7 weeks after full bloom and repeat 7-10 days later; follow with a third application 3 weeks later. 2.5 gallons Raynox may be applied in 97.5 gallons per acre or 47.5 gallons to the side of the trees exposed to afternoon sun. Not known to be toxic to beneficials.
Surround Crop Protectant	foliar/canopy spray		Difficult to remove from fruit after harvest.

Sunscauld to Woody Tissue

CATEGORY: Abiotic

CAUSE: Environmental

DAMAGE: Bark splits



John Strang, University of Kentucky

DESCRIPTION

Sunscauld injury is often associated with the southwestern side of lower trunks or upward-facing branches. Cambium tissue can be severely damaged during rapid temperature fluctuations in late winter or early spring as trees begin active growth and bark begins to slip. Spring sunscauld occurs during an extreme cold-warm-cold temperature cycle, which is common when nights are cold and days are warm. Contraction of bark causes it to split and separate from the tree at the cambium layer. These wounds often do not heal and provide an entry for insects and disease pathogens.



Sunscald can also occur during summer months when temperatures rise to extreme levels and thin bark is suddenly exposed to hot, direct sun. Summer sunscald is common as a result of late-season pruning or during a sudden surge of heat.

Young trees are more susceptible to sunscald injury because of thin bark and lack of shading from leaves. Older trees are less susceptible to scalding, but damage may occur during extreme conditions.

IMPORTANCE

Minor - Sunscald injury occurs infrequently, but may result in tree losses of approximately 2%. Acreage affected can range from 0% to 5%.

MANAGEMENT

Critical Timing of Management Practices

Protect susceptible tissue in autumn to help eliminate or reduce sunscald the following spring. Avoid direct sun exposure during hot summer months.

Cultural Practices & Physical Methods

- Retain some leaf cover when pruning.
- Protect young tree trunks with spiral white plastic wrap tree guards.
- Apply white latex paint in autumn to the lower several feet of trunk and to tops of horizontal, exposed limbs to help reflect sunlight.

Watercore

CATEGORY: Abiotic

CAUSE: Physiological

DAMAGE: Causes fruit flesh to become water-soaked



John Strang, University of Kentucky

DESCRIPTION

Watercore appears as water-soaked areas within fruit as a result of over-maturity and high sorbitol (sugar) content. It is associated with cool night temperatures during harvest, large fruit size, high nitrogen levels, and high sunlight exposure. It also occurs when there are few fruit on the tree.

IMPORTANCE

Moderate - Watercore occurs annually and may affect 10% of Kentucky acreage each season. Yield losses are estimated at 2%.

MANAGEMENT

Cultural Practices

- Monitor fruit ripening; harvest before fruit become overripe.
- Mild to moderate watercore usually disappears in storage.

Resources

- IPM Scouting Guide for Common Problems of Apple, University of Kentucky (ID-219)
<http://www2.ca.uky.edu/agcomm/pubs/ID/ID219/ID219.pdf>
- Effects of Glyphosate on Apple Tree Health. Rosenberger, D., C. Watkins, M. Miranda-Sazo, C. Kahlke, M. Farglone, J. Nock, and A Rugh. 2013. Cornell University. New York Fruit Quarterly. Vol 21 (2) Winter 2013.
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Credits & Acknowledgements

CONTACT, CONTRIBUTOR, AUTHOR & EDITOR

Dr. Nicole Ward Gauthier,
Extension Assistant Professor for Fruit, Ornamentals
& Hemp
Department of Plant Pathology
University of Kentucky, Lexington, KY
nicole.ward@uky.edu 859-218-0720
<http://plantpathology.ca.uky.edu/person/nicole-ward-gauthier>

CONTRIBUTOR, AUTHOR & EDITOR

Ms. Kimberly Leonberger
Extension Associate for Residential Horticulture
Department of Plant Pathology
University of Kentucky, Lexington, KY
kimberly.leonberger@uky.edu 859-218-0786
<http://plantpathology.ca.uky.edu/person/kimberly-leonberger>

CONTRIBUTOR & AUTHOR

Dr. Ricardo Bessin
Extension Professor for Fruit, Vegetables & Field
Crops
Department of Entomology
University of Kentucky, Lexington, KY
rbessin@uky.edu 859-257-7456
<https://entomology.ca.uky.edu/person/ric-bessin>

Dr. Matthew Springer
Assistant Extension Professor of Wildlife
Management
Department of Forestry
University of Kentucky, Lexington, KY
mattspringer@uky.edu 859-257-8633
<http://forestry.ca.uky.edu/matthew-springer>

Dr. John Strang
Extension Professor for Fruit & Vegetables
Department of Horticulture
University of Kentucky, Lexington, KY
jstrang@uky.edu 859-257-5685
<http://www.uky.edu/hort/people/john-strang>

CONTRIBUTOR & AUTHOR

Dr. Shawn Wright
Extension Associate Professor for Fruit, Vegetables
& Medicinal Herbs
Department of Horticulture
Robinson Center for Appalachian Resource
Sustainability
University of Kentucky, Jackson, KY
shawn.wright@uky.edu 606-666-2438 ext. 234
<http://www.uky.edu/hort/people/shawn-wright>

EDITOR & DESIGNER

Ms. Cheryl Kaiser
Department & Extension Support Staff Associate
Department of Plant Pathology
University of Kentucky, Lexington, KY
cakaiser@uky.edu 859-219-1289
<http://plantpathology.ca.uky.edu/person/cherly-kaiser>

CONTRIBUTING ASSOCIATES

Ms. Bernadette Amsden
Research Analyst for Plant Pathology

Mr. Daniel Becker
Extension Associate for Horticulture

Mr. Edward Dixon
Research Analyst for Plant Pathology

Ms. Patty Lucas
IPM Extension Associate for Entomology

Mr. Chris Smigell
Extension Associate for Horticulture

ADDITIONAL CONTACTS

Matthew Dixon
Meteorologist, Ag Weather Center

Tom Priddy
Meteorologist, Ag Weather Center

Wanhong Wang
IS Technical Support Specialist, Ag Weather Center