Pomegranate

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PEST MANAGEMENT GUIDELINES FOR AGRICULTURE

Contents (Dates in parenthesis indicate when each topic was updated)

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UC PEER REVIEWED

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The UC IPM Pest Management Guidelines are available from:

- **Online**: http://ipm.ucanr.edu
- **UC Cooperative Extension:** County Offices
- **University of California**
  ANR Communication Services
  2801 Second Street
  Davis, CA 95618-7779
  530-750-1213; 800-994-8849

Updates: These guidelines are updated regularly. Check with your University of California Cooperative Extension Office or the UC IPM website for information on updates.

Note to readers: These guidelines represent the best information currently available to the authors and are intended to help you make the best choices for an IPM program. Not all formulations or registered pesticides are mentioned. Always read the label and check with local authorities for the most up-to-date information regarding registration and restrictions on pesticide use. Check with your agricultural commissioner for latest restricted entry intervals.

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General Information

(Reviewed 12/18)

RELATIVE TOXICITIES OF INSECTICIDES AND MITICIDES USED IN POMEGRANATE TO NATURAL ENEMIES AND HONEY BEES (12/18)

Common name (Example trade name)	Mode of action[1]	Selectivity [2] (affected groups)	Predatory mites [3]	General predators [4]	Parasites [4]	Honey bees [5]	Duration of impact to natural enemies [6]
azadirachtin (Aza-Direct)	un	broad (insects, mites)	M	L/M	L/M	II	short
Bacillus thuringiensis ssp. *kurstaki*	11A	narrow (caterpillars)	L	L	L	III	none
buprofezin (Applaud)	16	narrow (sucking insects)	L	H[8]	L	II	long
chlorantraniliprole (Altacor)	28	narrow (caterpillars)	—	—	—	III	—
clothianidin (Belay)	4A	narrow (sucking insects)	—	M/H	M/H	I	long
hydramethylnon (Amdro Pro bait)	20A	narrow (ants)	—	—	—	—	—
flupyradifurone (Sivanto Prime)	4D	broad (sucking insects)	L	M	H	I	moderate
Imidacloprid, systemic (Admire Pro)	4A	narrow (sucking insects)	—[7]	—	H	I	short to moderate
Imidacloprid, foliar (Admire Pro)	4A	narrow (sucking insects)	—[7]	—	H	I	short to moderate
methomyl (Lannate)	1A	broad (insects, mites)	H	H	H	I	moderate
methoxyfenozide (Intrepid)	18	narrow (caterpillars)	L	L	L	II	none
mineral oil	—	broad (exposed insects, mites)	L[9]	L	L	II	short to none
neem oil (Trilogy)	—	broad (soft-bodied insects)	L	L	L	II	short
pyrethrins (Evergreen, PyGanic)	3A	broad (insects)	—	M	M	I	short
rosemary oil/peppermint oil (Ecotrol)	—	broad (soft-bodied insects)	L	L	L	III	short
spinetoram (Delegate)	5	broad (aphids, caterpillars, scales)	L/M	M	M/H	II	moderate[10]
spinosad (Entrust)	5	narrow (aphids, caterpillars, scales)	L	M	L/M	II	short
spirotetramat (Movento)	23	narrow (sucking insects)	H	L	L	II	short
sulfur	un	narrow (mites, thrips)	L/H	M/L	H	III	short

H = high M = moderate L = low — = no information un = unknown or uncertain mode of action

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers for insecticides and miticides are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at www.irac-online.org.

2 Selectivity: *Broad* means it affects most groups of insects and mites; *narrow* means it affects only a few specific groups.

3 Toxicities are generally to western predatory mite, *Galendromus occidentalis*. Where differences have been measured in toxicity of the pesticide-resistant strain versus the native strain, these are listed as pesticide-resistant strain/native strain.

4 Toxicities are averages of reported effects and should be used only as a general guide. Actual toxicity of a specific insecticide depends on factors including the application rate, environmental conditions, and life stage and species of parasite or predator.

5 Ratings are as follows: I—Do not apply or allow to drift to plants that are flowering; II—Do not apply or allow to drift to plants that are flowering, except when the application is made between sunset and midnight if allowed by the pesticide label and regulations; III—No bee precaution, except when required by the pesticide label or regulations. For more information about pesticide synergistic effects, see *Bee Precaution Pesticide Ratings* (Available online at http://ipm.ucanr.edu/beeprecaution/*)*.

6 Duration: *Short* means hours to days; *moderate* means days to 2 weeks; and *long* means many weeks or months.

7 May cause an increase in spider mites.

8 Kills lady beetles.

9 Rating depends on rate used.

10 Residual is moderate if solution is between pH of 7 to 8.

Acknowledgments: This table was compiled based on research data and experience of University of California scientists who work on a variety of crops and contribute to the Pest Management Guideline database, and from Flint, M. L. and S. H. Dreistadt. 1998. *Natural Enemies Handbook: An Illustrated Guide to Biological Pest Control*, UC ANR Publication 3386.

FUNGICIDE EFFICACY (3/22)

Fungicide	Resistance risk (FRAC group number)	Alternaria fruit rot	Botrytis fruit rot/ gray mold
Preharvest			
Merivon*	medium (7/11)	2	2 (3)
Ph-D	high (19)	2	2 (3)
Postharvest			
BioSpectra, CeraFruta***	medium (48)	0	3
Penbotec/Pyrimethanil***	high (9)	1	4
Scholar/FDL***	high (12)	0	4

Rating: 5 = excellent and consistent, 4 = good and reliable, 3 = moderate and variable, 2 = limited and/or erratic, 1 = minimal and often ineffective, 0 = ineffective.

*** Pending registration in California.**

***** In California, postharvest fruit registration only.**

Adaskaveg et al., 2022. *Fungicides, Bactericides, Biocontrols, and Natural Products for Deciduous Tree Fruit and Nut, Citrus, Strawberry, and Vine Crops in California.* (PDF)

MOST EFFECTIVE TREATMENT TIMINGS FOR KEY DISEASES (3/22)

Note: Not all indicated timings may be necessary for disease control.

Disease	Dormant	Early-bloom	Mid-bloom	Late-bloom	Preharvest	Postharvest
Alternaria fruit rot	0	1[1]	1	1	0	0
Gray mold (botrytis fruit rot)	0	ND	ND	ND	1[2]	3

Rating: 3 = most effective, 2 = moderately effective, 1 = least effective, and 0 = ineffective (ND = No data).

[1] Pomegranates have a long, protracted bloom, thus apply when conditions are favorable for disease (i.e., wet conditions).

[2] Preharvest treatments are highly variable in efficacy due to difficulty in fungicide coverage into the fruit "crown".

Adaskaveg et al., 2022. *Fungicides, Bactericides, Biocontrols, and Natural Products for Deciduous Tree Fruit and Nut, Citrus, Strawberry, and Vine Crops in California.* (PDF)

Insects and Mites

(Reviewed 12/18)

ANTS (12/18)

Scientific names

Native gray ant: *Formica aerata*
Southern fire ant: *Solenopsis xyloni*
Argentine ant: *Linepithema humile*

DESCRIPTION OF THE PEST

Ants are commonly found in pomegranate orchards and reducing ant numbers improves the biological control of honeydew-producing insects such as aphids. Unfortunately, there are few chemical choices for ant control currently available, but cultural control methods may be an option. Ants become active in spring as the soil temperature warms and peak in midsummer through early fall.

Native gray ants

Native gray ant (a common species in the San Joaquin Valley) is gray and considerably larger than the other two species. It moves about in a stop-and-start fashion. These ants construct nests with multiple entrance holes in areas with bare soil that are partially shaded. Native gray ant is relatively larger than southern fire ant or Argentine ant. In contrast to Argentine and fire ants, the native gray ant is solitary and its importance in disrupting biological control is often underestimated.

Southern fire ant

The southern fire ant is light reddish brown with a black abdomen. During hot daytime temperatures, the foraging activity of this species decreases considerably, while the native gray ant and Argentine ant remain active. Southern fire ant generally constructs nests in shaded areas with multiple, relatively small entrance holes. The tailings dispersed around the entrances appear fine-grain and hilly. Southern fire ant does not form colonies as large as those of the Argentine ant. When disturbed, southern fire ant will swarm from their nest and aggressively attack; they possess a painful bite and sting that can cause allergic reactions.

Argentine ant

The Argentine ant is less common. They are small, uniformly deep brown ants. Workers travel in characteristic trails on trees, the ground, or irrigation lines. This species typically constructs nests at the tree dripline near a moisture source and nests have several entrance holes.

DAMAGE

Most pest ants feed on honeydew excreted by aphids, mealybugs, whiteflies, and various soft scale. As part of this relationship, ants protect these insects from their natural enemies, thus interrupting biological control of the honeydew-producing pests. Native gray ant, southern fire ant, and Argentine ant each actively tend honeydew-producing insects.

In addition, Argentine ants and southern fire ants can plug up irrigation sprinklers. Southern fire ants have a painful sting that may cause allergic reactions.

MANAGEMENT

Ants can be very disruptive to an IPM program and play a key role in why aphids, whiteflies, mealybugs, and scales become a problem in pomegranate orchards. Fire ant numbers can be reduced with the use of solid, protein-based insecticide baits in bait stations. Bait can only be used when no fruit is present, limiting its use to early spring and late fall. There are currently no registered liquid sugar baits for native gray or Argentine ants, which will not be attracted to the solid bait. Cultural control methods may be an option.

Biological Control

No effective natural enemies of ants currently are known.

Cultural Control

Cultural control options exist, but their use may have additional costs and other effects on management:

- Cultivation reduces ant numbers but may create so much dust that it disrupts biological control of other pests.
- Flood irrigation can reduce ant numbers in orchard systems. However, a possible loss in irrigation and weed management efficiency should be considered if the flood irrigation method is used.

Other cropping systems have shown the value of common vetch, *Vicia sativa*, grown as a spring cover to attract native gray ants from the honeydew-producing insects in the trees to the many nectarines in the cover crop. In grapes, an 80:20 mix of vetch: Merced rye planted in the fall or winter did well in attracting ants in the spring and early summer. Whether cover crops are attractive to other ants or if it provides this level of attractiveness in pomegranate has not been researched.

Organically Acceptable Methods

Cultural controls are the only organically acceptable control methods for ants.

Monitoring and Treatment Decisions

Use visual searches to monitor the orchard in spring when honeydew-producing insects, such as aphids, appear. If fire ants are present, then apply bait in stations before fruit is present in the orchard.

Insecticides

There are currently no insecticides available for ants that feed primarily on sugary liquids, such as Argentine and native gray ants. For ants that feed primarily on proteins, such as fire ants, one insecticidal bait is available but has to be used in bait stations when no fruit is present. This bait has a slow-acting toxicant that worker ants collect and feed to other ants, including nest-building immatures and queens. For the most effective and economical ant control, treat in early spring when ant numbers are just beginning to increase and are becoming active on the ground surface.

Corncob grit and oil baits

The solid bait uses defatted corncob grit treated with soybean oil as the food attractant plus a registered insecticide. It is effective for the primarily lipid and protein-feeding fire ants. Place bait stations out early in the morning or late in the day when ants are active and will take the bait into the nest. Generally, corncob grit type bait stations are placed throughout the acreage that needs to be treated. However, spot-treating can be employed by placing a bait station a few feet from a nest entrance. This is preferred since it concentrates bait nearer to the ants.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table****. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*			
A. HYDRAMETHYLNON			
(Amdro Pro bait)	Label rates	12	See label
MODE-OF-ACTION GROUP NUMBER: 20A			
COMMENTS: Use for fire ant control only. Must be applied in an EPA approved bait station. Do not apply when pomegranate fruit is present on trees.			

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases, the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

CHERRY LEAFHOPPER (12/18)

Scientific name: *Fieberiella florii*

DESCRIPTION OF THE PEST

Cherry leafhopper is an occasional pest of pomegranate. Adult cherry leafhoppers are brown and their shape and color mimic the buds of cherry. Nymphs are green and shiny. This leafhopper overwinters as nymphs on ornamental hosts (privet, boxwood, myrtle, hawthorn, pyracantha, *Ceanothus*, *Cotoneaster*, crabapple, and apple) and as eggs on ornamental hosts and deciduous fruit trees. Cherry leafhopper is found in pomegranate orchards situated near other hosts, especially cherry, its preferred host. There are three periods of adult activity: mid-April through May; July; and September through October.

DAMAGE

Damage is mainly due to nymphs producing honeydew. Honeydew accumulates on fruit in thick, quarter-inch blotches. The black sooty mold growing on the honeydew can be washed off, but the fruit may fail to color underneath.

Cherry leafhopper vectors disease in cherry but does not vector disease in pomegranate.

MANAGEMENT

Look for cherry leafhopper from April through July. If easily found, apply an insecticide in July or August when nymphs are small.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table.*** *When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*

A.	BUPROFEZIN (Applaud) MODE-OF-ACTION GROUP NUMBER[1]: 16 COMMENTS: Controls other leafhoppers, but research has not been done on cherry leafhopper in pomegranate.	12–34.5 oz	12	14
B.	METHOMYL* (Lannate SP) MODE-OF-ACTION GROUP NUMBER[1]: 1A COMMENTS: Disruptive to natural enemies of mealybugs, caterpillars, soft scales, aphids, and other pests. Use of this pesticide may result in outbreaks of these pests. Methomyl is also toxic to bees and should not be applied when bees are actively foraging.	1 lb	48	14
C.	PYRETHRINS (PyGanic EC 1.4)# MODE-OF-ACTION GROUP NUMBER[1]: 3A	2–4 pt	12	When dry
D.	AZADIRACHTIN (Aza-Direct)# MODE OF ACTION: un	2–3.5 pt	4	0
E.	NEEM OIL (Trilogy)# MODE OF ACTION: — (a botanical insecticide)	1–2%	4	0
F.	ROSEMARY OIL/PEPPERMINT OIL (Ecotrol EC)# MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: Volumes up to 100, 150, and 200 gallons/acre, use 4, 5, and 6 pints/acre respectively.	2–6 pt	0	0

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases, the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers ("un"=unknown or uncertain mode of action) are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

— Not applicable.

Acceptable for use on organically grown produce.

CITRUS FLAT MITE (12/18)

Scientific name: *Brevipalpus sp.*

DESCRIPTION OF THE PEST

Citrus flat mites are common pests of pomegranate fruit. Citrus flat mites are very small and difficult to see, even with a hand lens. They are sluggish, translucent, flat, and oblong. Adults have internal spots of red and brown. These mites overwinter under flakes of bark on large branches. They move to the leaves and fruit in summer, with numbers increasing in June, peaking in July and August, and then gradually declining.

DAMAGE

Citrus flat mite feeding results in a brown scabbing or leathering ("alligator skin") of the fruit that looks similar to sunburn. Occasionally, the damage can be quite serious. Mite damage starts at the stem end and the brown discoloration extends further than the cracking. Mites and their cast skins may be found in the cracks. Sunburn and other unknown causes of leathering can be mistaken for flat mite damage. If the fruit surface next to the stem is not damaged, flat mites are not the cause.

MANAGEMENT

Predaceous mites may keep flat mites below an economically damaging level, but most growers use preventive applications of sulfur in early summer. It has not been documented in pomegranate, but in other crops, sulfur can disrupt the natural enemies of other pests (e.g., mealybug and soft scale). However, it is the best control method to prevent flat mite damage.

Biological Control

A predaceous mite has been observed associated with flat mite in pomegranates and likely keeps this pest in check in some orchards.

Organically Acceptable Methods

Some formulations of sulfur are organically acceptable.

Monitoring and Treatment Decisions

Monitor for damage starting in mid to late May by examining the stem end of fruit for scabbing and the presence of flat mites with a high-power hand lens (15–20x) or microscope. If flat mites are present, apply sulfur immediately. A second application of sulfur may be needed in July or August. Sulfur works better in warm weather. Wettable sulfur is less disruptive to predators.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table****. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*

A. SULFUR DUST 98%#
(various products) — 30–50 lb — 24 — 0
MODE-OF-ACTION GROUP NUMBER[1]: un (an inorganic miticide)
COMMENTS: Best results are obtained by ground treatments; however, aerial treatments are effective. Use higher rates by air. Check that the formulation you are using is acceptable for organic use.

B. WETTABLE SULFUR
(Microthiol Disperss)# — 3–10 lb — 24 — —
MODE-OF-ACTION GROUP NUMBER[1]: un (an inorganic miticide)
COMMENTS: May be applied by ground or air. Check that the formulation you are using is acceptable for organic use.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases, the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

\# Acceptable for use on organically grown produce.

— Not applicable.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers ("un"=unknown or uncertain mode of action) are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

COTTON APHID (12/18)

Scientific name: *Aphis gossypii*

DESCRIPTION OF THE PEST

Aphids are among the most serious and widespread pests in pomegranate orchards, but they may be sufficiently controlled by natural enemies.

Cotton aphid numbers build up rapidly on growing shoots in the spring and again in the late summer or fall. During the fall months, cotton aphids move into pomegranate orchards from weeds, cotton, melons, and citrus, depositing eggs on pomegranate stems. These eggs overwinter on pomegranate and in the early spring (end of March) the eggs hatch and nymphs move to the leaves and stems on the shoot tips. The first generation that develops from the eggs produces the apterous (wingless) form and the second generation produces both winged and wingless forms. Subsequent generations do not produce eggs, but instead reproduce viviparously (females give birth to nymphs). In the early spring, winged adults fly to other crops such as cotton, melons, and citrus. Cotton aphid can be found year-round on pomegranate leaves and blossoms; however, numbers are highest in spring and fall.

Cotton aphid is highly variable in body size and color. Nymphs and adults of wingless cotton aphids vary in color from yellow to green to nearly black. Nymphs that are developing into winged adults look very different from the nymphs developing into wingless adults: they bear small welts or protuberances on the sides of their bodies that will become their wings.

DAMAGE

Reduced shoot growth and leaf damage of pomegranate is not typical with cotton aphid, even if spring numbers are high. Dense colonies can occur on young fruit without causing any visible damage. Occasionally, abundant numbers of aphids in the spring can cause leaf buds to drop, stunting very young trees, or fruit to drop, which is later replaced with smaller-sized, less valuable fruit.

Later in the season, as fruit approaches ripening in August, aphid honeydew that collects between touching fruit may result in rotten spots on the skin. In addition, sooty mold grows on the honeydew on the outside of the fruit, which can be difficult to remove. Aphids clustering on mature leaves produce more honeydew and are less controlled by natural enemies than aphids growing on shoots and fruit.

MANAGEMENT

Aphid management tactics vary depending on the severity of the infestation and include biological control and insecticides.

Biological Control

Biological control can be effective in controlling aphids, especially in the spring.

Parasites include:

- *Lysiphlebus testaceipes* (Aphidiidae)

Predatory lady beetles (Coccinellidae) include:

- Ashy gray lady beetle, *Olla v-nigrum*
- Nine-spot lady beetle, *Coccinella novemnotata*
- Multicolored Asian lady beetle, *Harmonia axyridis*
- Convergent lady beetle, *Hippodamia convergens*

There are also predatory larvae, such as:

- Syrphid flies (Syrphidae)
- Cecidomyiid flies
- Lacewings

Natural enemy control slows during the heat of summer and early fall, but heat also suppresses the aphids. In the fall, as aphid numbers increase, biological control also increases.

Ants hinder natural enemies, and so reducing ant numbers will improve the success of biological control.

Cultural Control
Maximize tree health (proper nutrients and irrigation) to help trees withstand pests. Aphid numbers increase easily on stressed trees.

Organically Acceptable Methods
Pyrethrins (Pyganic), azadirachtin (Aza-Direct), neem oil (Trilogy), and peppermint plus rosemary oil (Ecotrol) are all acceptable for use on organically grown pomegranate. Coverage is very important to achieve efficacy with these products and persistence is very short. Multiple applications may be needed. Treatment of overwintering eggs will result in the best control.

Monitoring and Treatment Decisions
In the winter and early spring, monitor for cotton aphid by searching for black eggs deposited on twigs. In the very early spring, when buds begin to break, the eggs hatch and the nymphs move to the new foliage. From March through June aphids are most numerous on the tips of branches where the new foliage is produced. During the summer, aphids may be difficult to find, but then in late summer their numbers may begin to increase.

In areas with weak trees and where natural enemies are not sufficient to lower high aphid numbers, pesticide application may be needed. Short-term control can be achieved with pyrethrins (Evergreen), azadirachtin (Aza-Direct), neem oil (Trilogy) and rosemary plus peppermint oil (Ecotrol). Two or more applications may be necessary. However, these products are fairly selective, allowing natural enemies to survive and assist with control.

The best time to apply imidacloprid (Admire Pro) or clothianidin (Belay) through the drip system is in October. Imidacloprid and clothianidin cannot be applied from prebloom (bud elongation in February) through bloom (August) due to bee hazard issues or when fruit is on the tree (June–October). Additionally, systemic imidacloprid takes several weeks for uptake, so apply it in October to reduce egg-laying and the number of overwintering aphids that emerge in spring. Clothianidin has a more rapid systemic uptake than imidacloprid.

Be aware that the broad-spectrum foliar imidacloprid (Admire Pro) and methomyl (Lannate) can disrupt biological control of other pests such as mealybugs, caterpillars, and soft scale, causing secondary outbreaks of these pests. Do not apply imidacloprid during bloom (to protect bees) or when fruit is present in the orchard. Methomyl is also toxic to bees; do not apply it when bees are actively foraging.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table****. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*			
A. FLUPYRADIFURONE (Sivanto Prime) MODE-OF-ACTION GROUP NUMBER[1]: 4D	10.5–14 fl oz	12	7
B. SPIROTETRAMAT (Movento) MODE-OF-ACTION GROUP NUMBER[1]: 23	8–10 fl oz	24	1
C. IMIDACLOPRID (systemic) (Admire Pro) MODE-OF-ACTION GROUP NUMBER[1]: 4A	7–14 fl oz	12	0
COMMENTS: Do not apply prebloom (during bud elongation; March–April) or during bloom (May–August). Do not apply when fruit are present (June–October). Apply systemic imidacloprid via chemigation. Review and follow the California neonicotinoid regulations effective January 1, 2024. Application of this insecticide is prohibited if managed pollinators will be used during the growing season. The use of multiple application methods or neonicotinoid active ingredients affected may also be prohibited.			

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
D. IMIDACLOPRID (foliar) (Admire Pro) MODE-OF-ACTION GROUP NUMBER[1]: 4A COMMENTS: Can be disruptive to natural enemies. Do not apply prebloom (during bud elongation; March–April) or during bloom (May–August). Do not apply when fruit are present (June–October). Review and follow the California neonicotinoid regulations effective January 1, 2024. Application of this insecticide is prohibited if managed pollinators will be used during the growing season. The use of multiple application methods or neonicotinoid active ingredients affected may also be prohibited.	2.8 fl oz	12	7
E. CLOTHIANIDIN (Belay) MODE-OF-ACTION GROUP NUMBER[1]: 4A COMMENTS: Do not apply during bloom. Review and follow the California neonicotinoid regulations effective January 1, 2024. Application of this insecticide is prohibited if managed pollinators will be used during the growing season. The use of multiple application methods or neonicotinoid active ingredients affected may also be prohibited.	4–6 fl oz	12	7
F. METHOMYL* (Lannate SP) MODE-OF-ACTION GROUP NUMBER[1]: 1A COMMENTS: Disruptive to natural enemies of mealybugs, caterpillars, soft scales, aphids, and other pests. Use of this pesticide may result in outbreaks of these pests. Methomyl is also toxic to bees and should not be applied when bees are actively foraging.	1 lb	48	14
G. PYRETHRINS/PIPERONYL BUTOXIDE (Evergreen EC 60-6) MODE-OF-ACTION GROUP NUMBER[1]: 3A	12–16 oz	12	When dry
H. MINERAL OIL (PureSpray Green)# MODE OF ACTION: Contact including smothering and barrier effects.	See label	4	0
I. PYRETHRINS (PyGanic EC 1.4)# MODE-OF-ACTION GROUP NUMBER[1]: 3A	2–4 pt	12	When dry
J. AZADIRACHTIN (Aza-Direct)# MODE OF ACTION: un	2–3.5 pt	4	0
K. NEEM OIL (Trilogy)# MODE OF ACTION: — (a botanical insecticide)	1–2%	4	0
L. ROSEMARY OIL/PEPPERMINT OIL (Ecotrol EC)# MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: Volumes up to 100, 150, and 200 gallons/acre, use 4, 5, and 6 pints/acre respectively.	2–6 pts	0	0

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases, the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers ("un"=unknown or uncertain mode of action) are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

* Permit required from county agricultural commissioner for purchase or use.

\# Acceptable for use on organically grown produce.

— Not applicable.

FALSE CHINCH BUG (12/18)

Scientific name: *Nysius raphanus*

DESCRIPTION OF THE PEST

False chinch bug is an occasional pest of young pomegranate. The adult is gray to light brown, elongate, and about 0.12 inch (3 mm). Females lay eggs on host plants or in cracks in the soil. The pale gray nymphs have reddish-brown abdomens. There are four to seven generations per year, with all stages present throughout the year.

False chinch bug nymphs spend the winter on weeds. During early spring, bugs primarily feed on foliage, stems, and seeds of cruciferous weeds. Important weeds that serve as hosts include wild mustard, wild radish, shepherd's-purse, and London rocket. When vegetation dries or is cut, bugs move to feed on virtually any nearby green plants, including irrigated fruit and nut trees, grains, and vegetable crops. The most serious infestations result from spring migrations; however, fall migrations can also occur. Adult bugs may swarm around trees in a manner superficially resembling leafhoppers.

DAMAGE

Feeding damage is most severe in the spring as the trees start to leaf. Damage occurs when nymphs migrate from drying weeds or after mowing or plowing weeds. Migration may occur at any time for several days from April to October but are most common in May through July. Chinch bugs do not stay in one spot for very long and can spread out over an orchard within a week.

Large numbers of nymphs will stream over the dirt looking for any green vegetation. Heavy nymph infestations can kill sucker shoots in less than a day. This damage can occur within hours due to a toxin injected while feeding. The leaves dry up and are covered with fecal spots. Usually the nymphs do not climb higher than 1 to 2 feet on trees, so they pose little risk to mature trees. Young trees 1 to 2 years old may suffer severe damage.

MANAGEMENT

Control weeds, especially in the first two years after planting pomegranates. Reducing bug numbers in weeds and neighboring agricultural fields prevents migration into orchards. Where possible, manage weedy areas such as ditches, pastures, and grasslands adjacent to orchards to prevent migration from these areas into pomegranate orchards. If heavy infestations of nymphs threaten young trees, treat immediately.

Cultural Control

Disc under shepherd's-purse, London rocket stands, and other host weeds about 3 weeks before budbreak in young pomegranate trees. Waiting to disc after budbreak may result in heavy movement of bugs from the weeds to the trees. Creating a ditch filled with water between the migrating bugs and the orchard may prevent movement into the orchard.

Organically Acceptable Methods

Cultural control methods and applications of rosemary oil plus peppermint oil (Ecotrol) or pyrethrins may be effective.

Monitoring and Treatment Decisions

Visually inspect or use a sweep net to monitor weeds in fields or borders near young pomegranates for developing populations. False chinch bugs often hide under weeds at the soil line during the day. Visually inspect weeds by pulling them out of the ground, exposing the bugs to light. The false chinch bugs will begin to move around, making them easier to spot. In addition to weeds, inspect grow tubes or cartons used to protect young trees for false chinch bugs hiding inside. Be aware that populations will be moving around so you may need to monitor the entire orchard.

If possible, use cultural control methods or pesticides to manage false chinch bugs in weeds in and adjacent to the orchard before migrations occur. Pay special attention when weeds are drying or after mowing or discing. Treat for chinch bug in neighboring crops according to that crop's Pest Management Guidelines, to prevent migration into pomegranate. When nymphs are migrating into orchards, spraying them on the ground may be enough to prevent damage.

If a pesticide spray for young trees becomes necessary, methomyl (Lannate) is the most effective registered pesticide. However, methomyl disrupts natural enemies needed for other pests. Softer insecticides such as organic pyrethrins (PyGanic) have a very short residual and are less effective.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table****. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*			
A. METHOMYL* (Lannate SP) MODE-OF-ACTION GROUP NUMBER[1]: 1A COMMENTS: Disruptive to natural enemies of mealybugs, caterpillars, soft scales, aphids, and other pests. Use of this pesticide may result in outbreaks of these pests. Methomyl is also toxic to bees and should not be applied when bees are actively foraging.	1 lb	48	14
B. PYRETHRINS (PyGanic EC 1.4)# MODE-OF-ACTION GROUP NUMBER[1]: 3A	2–4 pt	12	0

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

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1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers ("un"=unknown or uncertain mode of action) are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

\# Acceptable for use on organically grown produce.

FILBERTWORM (12/18)

Scientific name: *Cydia latiferreana*

DESCRIPTION OF THE PEST

Filbertworm is a native insect found throughout California and is an occasional pest of pomegranate. The small, bronze, copper, or reddish-brown moths emerge in late spring to early summer. The moth is characterized by a thin, brown band running across the top pair of wings.

After emergence, eggs are laid singly, hatching in 8 to 11 days. Eggs are scalelike, flattened oval in shape, and similar in appearance to codling moth eggs. Filbertworm eggs are white when newly laid and turn darker as hatching approaches.

Larvae overwinter in organic matter or soil, can reach 0.5 inch (1.3 cm) in length, and range from beige to pink with a dark brown to black head. Pupation occurs in a silk cocoon the next spring. One generation with a partial second has been observed in cool areas such as Oregon. However in warm areas of California, two generations per year is probable, with second-generation adults appearing in the fall.

DAMAGE

Filbertworm can cause serious damage in pomegranates. Infestations have been seen in only a few orchards, most of which are in close proximity to alternate hosts, such as oak.

In July, the larvae bore into the fruit similar to codling moth, a close relative. Like codling moth damage, frass is often found at the entrance of the larval tunnels.

MANAGEMENT

Cultural control methods, such as removing old fruit, can help reduce filbertworm numbers. Pheromone traps will help you determine the timing of sprays.

Cultural Control

Remove all unharvested fruit, or disc fruit on the ground under, to prevent buildup of numbers in the orchard.

Organically Acceptable Methods

Cultural control methods and applications of spinosad (Entrust) are acceptable for use on organically grown pomegranate.

Monitoring and Treatment Decisions

Monitor with pheromone traps in orchards with a history of filbertworm problems. Place pheromone traps in the orchard and nearby oak trees in mid-April. Put two traps 5 to 6 feet high in the canopy in a 10-acre orchard, adding one more trap for every 5 additional acres. Check weekly, correctly identifying moths in case other moth species are caught.

At this time, there are no treatment thresholds. If moths are being caught in traps, make pesticide applications during the peak of the flight.

Looking for moth eggs can also be helpful to determine if numbers are high enough to treat. Treatment timing determined by looking for fruit stings from larval entrances is probably too late for control. However, larval stings can be useful to determine if the next generation may cause damage.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table****. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
A. CHLORANTRANILIPROLE (Altacor)	3–4.5 oz	4	1
MODE-OF-ACTION GROUP NUMBER[1]: 28			
B. METHOXYFENOZIDE (Intrepid 2F)	8–16 fl oz	4	7
MODE-OF-ACTION GROUP NUMBER[1]: 18			
C. SPINETORAM (Delegate WG)	4–7 oz	4	1
MODE-OF-ACTION GROUP NUMBER[1]: 5			
COMMENTS: Highly toxic to bees. Do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
D. METHOMYL* (Lannate SP)	1 lb	48	14
MODE-OF-ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Disruptive to natural enemies of mealybugs, caterpillars, soft scales, aphids, and other pests. Use of this pesticide may result in outbreaks of these pests. Methomyl is also toxic to bees and should not be applied when bees are actively foraging.			
E. SPINOSAD (Entrust)#	1.25–2.5 oz (0.45–0.83 oz/100 gal)	4	7
MODE-OF-ACTION GROUP NUMBER[1]: 5			
COMMENTS: Highly toxic to bees. Do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
F. BACILLUS THURINGIENSIS ssp. KURSTAKI# (various products)	Label rates	4	0
MODE-OF-ACTION GROUP NUMBER[1]: 11A			
COMMENTS: Least harmful to natural enemies. *Bacillus thuringiensis* is a stomach poison and must be consumed by the filbertworm. Must be applied when larvae are small. A second or third treatment may be required. Most effective if applied when weather forecasts predict 3 to 4 days of warm, dry weather. Larvae are more active and feed more in warm weather than in cooler or rainy weather.			

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1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

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\# Acceptable for use on organically grown produce.

GRAPE MEALYBUG (12/18)

Scientific name: *Pseudococcus maritimus*

DESCRIPTION OF THE PEST

Grape mealybug is found in many pomegranate orchards, but it only occasionally becomes a serious pest. Natural enemies usually keep grape mealybug numbers below economically significant levels.

Life Cycle

Grape mealybug females lay several hundred yellow to orange eggs in white, cottony egg masses that are typically located on the trunk under bark. The grape mealybug has two generations a year and usually overwinters in the egg stage. Just before or after budbreak in March, the eggs hatch and most of the crawlers move out to young shoots, where they nestle between the leaf petioles and the shoots. In late May to early June, mealybugs begin returning to the trunks where they mature and immediately begin depositing eggs.

The second generation hatches in early June through early July and the crawlers begin migrating to leaves and fruit. Many can be found in the sucker growth at the base of trees. Second-generation grape mealybugs mature and lay eggs under bark or on fruit beginning in August. If there is no fruit, they return to the trunks and lay eggs that will overwinter.

Appearance

Crawlers are light yellow to orange-brown and initially free of a waxy cover, but they soon begin secreting wax. Adults are about 0.2 inch (5 mm) long, flat, oval shaped, and have a white waxy covering with wax filaments sticking out from the circumference of the body. Longer filaments from the posterior end make these mealybugs appear to have "tails."

DAMAGE

Damage occurs when the mealybugs settle where two fruit touch, or inside the calyx of the fruit. Rot or discoloration can occur where the mealybugs deposit honeydew. Sometimes rot can start inside the calyx and spread to the interior of the fruit. Mature mealybugs or egg masses hidden in the calyx may also cause culling or could be missed and reach the consumer.

MANAGEMENT

Chemical control is best achieved with long-residual pesticides. Natural enemies often reduce the grape mealybug in pomegranates to numbers that are not economically significant.

Biological Control

Grape mealybug is attacked by a complex of parasites and predators in pomegranates. These natural enemies are often capable of providing sufficient control alone or when integrated with pesticide applications.

The parasites of grape mealybugs are all wasps in the family Encyrtidae. Parasites such as *Acerophagus notativentris* and *A. angelicus* produce multiple generations for each generation of the mealybug. Larger mealybugs host multiple parasites, and adult mealybugs may host as many as 8 to 12. A larger parasite, *Chrysoplatycerus splendens*, attacks adult mealybugs before they lay eggs. Parasitized mealybugs, called mummies, are yellow and the emergence holes may be seen with a hand lens.

Several predators feed on mealybugs. The predaceous gall midge *Dicrodiplosis californica* (Cecidomyiidae) feeds on all stages of mealybugs and is a key predator in the San Joaquin Valley. The adult resembles a small mosquito. The maggot starts out white and becomes red as it feeds. So far, this midge has only been observed in pomegranates near vineyards. It has a life cycle of about one month and is active in grapes from May until at least September.

A tiny brown lady beetle, *Nephus sordidus* (Cocinellidae), also feeds on all stages of mealybugs. The waxy larvae look superficially similar to mealybugs.

Green lacewings (Chrysopidae) are generalist predators that feed on mealybugs in addition to aphids and many other pests, contributing to the control of mealybugs in pomegranate. Eggs are laid on stalks, larvae are described as "tiny alligators", and the pupae surround themselves with round white cocoons.

Cultural Control
Thinning fruit so none are touching can reduce mealybug damage.

Organically Acceptable Methods
Biological and cultural controls are acceptable in organically managed pomegranate orchards. The neem tree extract, azadirachtin, is effective on immature grape mealybugs.

Monitoring and Treatment Decisions
Grape mealybugs first occur in isolated aggregations before spreading throughout the entire orchard. They should be monitored at different times in the season to gauge their numbers and also the effectiveness of their natural enemies. The larger instars, adults, and egg masses are easy to find under bark in late fall through late winter and in the spring from mid-April to early July. Also look for parasitized mummies and for predators and signs of their feeding.

Mealybugs are not tolerated on exported fruit, whereas a single mealybug on a fruit may be tolerable for some domestic markets. Multiple mealybugs where fruit touch or inside a calyx can lead to rot and discoloration. Thresholds have not been established, so monitor throughout the season and if mealybugs are observed and natural enemy numbers are low, then consider pesticide applications.

Insecticides with a long residual, such as buprofezin (Applaud), are best applied when second-generation crawlers begin moving around in mid-June. Insecticides with short residuals should be applied later, after most of the eggs have hatched, to target the exposed crawlers. Crawlers are hard to find in March, when they hide under leaf bases on the new shoots. In late June and July, they are often most abundant on sucker growth near the base of trees. Therefore, spray applications should include nozzles aimed low as well as directed at the tree.

Soil-applied products containing imidacloprid or clothianidin are effective on mealybugs feeding on leaves, but because they cannot be used during prebloom and bloom to protect bees, apply before bud elongation in early February (before February 15; this would also help control aphids).

Integrate chemical control with natural enemies. Buprofezin is soft on parasites and most predators except predatory beetles. Azadirachtin and rosemary plus peppermint oil are soft on most natural enemies.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table****. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*			
A. SPIROTETRAMAT (Movento) MODE-OF-ACTION GROUP NUMBER[1]: 23	8–10 fl oz	24	1
B. BUPROFEZIN (Applaud) MODE-OF-ACTION GROUP NUMBER[1]: 16 COMMENTS: Apply at peak of crawler emergence. Good coverage is essential.	34.5–46.0 oz	12	14
C. IMIDACLOPRID (systemic) (Admire Pro) MODE-OF-ACTION GROUP NUMBER[1]: 4A COMMENTS: Do not apply prebloom (during bud elongation; March–April) or during bloom (May–August). Do not apply when fruit is present (June–October). Apply systemic imidacloprid via chemigation. Review and follow the California neonicotinoid regulations effective January 1, 2024. Application of this insecticide is prohibited if managed pollinators will be used during the growing season. The use of multiple application methods or neonicotinoid active ingredients affected may also be prohibited.	7–14 fl oz	12	0
D. CLOTHIANIDIN (Belay) MODE-OF-ACTION GROUP NUMBER[1]: 4A	4–6 fl oz	12	7

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
COMMENTS: Do not apply during bloom. Review and follow the California neonicotinoid regulations effective January 1, 2024. Application of this insecticide is prohibited if managed pollinators will be used during the growing season. The use of multiple application methods or neonicotinoid active ingredients affected may also be prohibited.			
E. METHOMYL* (Lannate SP) MODE-OF-ACTION GROUP NUMBER[1]: 1A COMMENTS: Disruptive to natural enemies of mealybugs, caterpillars, soft scales, aphids, and other pests. Use of this pesticide may result in outbreaks of these pests. Methomyl is also toxic to bees and should not be applied when bees are actively foraging.	1 lb	48	14
F. AZADIRACHTIN (Aza-Direct)# MODE-OF-ACTION GROUP NUMBER[1]: un	1–3.5 pt	4	0
G. ROSEMARY OIL/PEPPERMINT OIL (Ecotrol EC)# MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: Volumes up to 100, 150, and 200 gallons/acre, use 4, 5, and 6 pints/acre respectively.	2–4 pt	0	0

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases, the REI exceeds the PHI The longer of two intervals is the minimum time that must elapse before harvest.

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— Not applicable.

\# Acceptable for use on organically grown produce.

KATYDIDS (12/18)

Scientific names
Angularwinged katydid: *Microcentrum retinerve*
Forktailed bush katydid: *Scudderia furcata*

DESCRIPTION OF THE PESTS

There are two species of katydids found in California orchards, the angularwinged katydid and forktailed bush katydid. The forktailed bush katydid occurs most frequently in pomegranate.

Forktailed bush katydid

The forktailed bush katydid is smaller and is not humpbacked. Nymphs have very long black and white banded antennae. Disk-shaped eggs are about 0.125 inch (3 mm) and inserted into the edges of leaves. Forktailed bush katydids emerge in April, about a month earlier than the angularwinged species. By midsummer, adults can be found. In June and July, oviposition begins, and continues through the summer and fall. Some of these eggs will hatch in July and August, whereas the rest will overwinter. There may be one or two generations of forktailed bush katydid per year.

Angularwinged katydid

The nymphs and adults of the angularwinged katydid have a distinct humpbacked appearance. Nymphs have very long, uniformly green antennae. Disk-shaped eggs are 0.125 to 0.15 inch long (3–6 mm), gray, and laid in two overlapping rows that form a long "tent" on the surface of twigs and branches. The angularwinged katydid emerges in May and has only one generation a year. Adult katydids appear in midsummer. Oviposition begins in June and July and continues throughout the summer to fall.

DAMAGE

Katydids occasionally become damaging pests in orchards that have not been sprayed with broad-spectrum pesticides or where tillage is not used. High numbers of these pests also occur in cycles, and they may cause damage one year and not the next. The angularwinged katydid is typically less damaging because it is less common.

Both nymphs and adults feed on leaves or fruit but the adults are the most damaging. Katydids tend to feed on a small section of a fruit (about 0.5 inch wide and 0.25 inch deep) before moving on to another feeding site. Hence, a few katydids may damage a large number of fruit in a short time. Katydids will feed on any size fruit. Feeding wounds heal over and enlarge into corky patches as the fruit expands. Damage to a young fruit can cause it to become severely distorted as it develops. Nymphs and adults also chew holes in foliage. Smaller nymphs feed in the middle of the leaf, creating small holes, whereas larger nymphs and adults feed on the leaf edge. Damage to fruit and foliage resembles that of green fruitworms.

MANAGEMENT

Look for katydid damage in the spring. Also, use a sweep net to detect katydids in the orchard cover crop or in weeds outside the orchard such as vetch, *Brassica*, and *Malva*. It is important to spray katydids early in the season if they have been a problem in the past and are detected in the orchard. Adult katydids migrate readily from adjacent orchards, and late season fruit is particularly susceptible to late season feeding.

Biological Control

No research has been conducted on parasites of katydids in pomegranate. In citrus, parasitic wasps will attack katydid eggs. However, the wasps typically do not reduce katydid numbers enough to prevent damage.

Cultural Control

It is unknown whether katydids migrate in from other neighboring crops or stay within the pomegranate orchard. If eggs are observed in pomegranate leaves, it may be helpful to shred leaves on the orchard floor in early spring to destroy forktailed bush katydid eggs.

Monitoring and Treatment Decisions

From April to May, examine leaves on shoots in the center of the tree for feeding damage. Early in the season when katydids are small, they create small holes in the center of the leaf, whereas cutworms and other leaf feeders will be feeding on the leaf edge. Look at 50 trees throughout the orchard and examine each tree for 30

seconds. If you find feeding damage, look for nymphs by shaking foliage onto large beating sheets; nymphs can be difficult to see on the tree. Generally, a pesticide application may be necessary if any of the foliage examined has feeding damage and katydid nymphs are detected.

Examine fruit on trees every other week starting in mid to late May to detect any developing problems in the orchard and take a fruit damage sample at harvest to assess the effectiveness of the current year's IPM program and to determine the needs of next year's program.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table****. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*			
A. SPINETORAM			
(Delegate WG)	4–7 oz	4	1
MODE-OF-ACTION GROUP NUMBER[1]: 5			
COMMENTS: Highly toxic to bees. Do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
B. CHLORANTRANILIPROLE			
(Altacor)	3–4.5 oz	4	1
MODE-OF-ACTION GROUP NUMBER[1]: 28			
C. METHOMYL*			
(Lannate SP)	1 lb	48	14
MODE-OF-ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Disruptive to natural enemies of mealybugs, caterpillars, soft scales, aphids, and other pests. Use of this pesticide may result in outbreaks of these pests. Methomyl is also toxic to bees and should not be applied when bees are actively foraging.			
D. SPINOSAD			
(Entrust)#	1.25–2.5 oz (0.45–0.83 oz/100 gal)	4	7
MODE-OF-ACTION GROUP NUMBER[1]: 5			
COMMENTS: Highly toxic to bees. Do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
E. AZADIRACHTIN			
(Aza-Direct)#	1–3.5 pt	4	0
MODE-OF-ACTION GROUP NUMBER[1]: un			
COMMENTS: Moderately effective on immature katydids. Must be contacted by spray so good coverage is essential.			

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases, the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

Acceptable for use on organically grown produce.

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LEAFFOOTED BUG (12/18)

Scientific names
Leptoglossus zonatus

DESCRIPTION OF THE PESTS

Leaffooted bugs are a frequent and highly damaging pest of pomegranate. Adult leaffooted bugs are large insects, 0.75 to 1 inch (19–25 mm) in length. They are gray to dark gray in color with a narrow white zigzag band across the back and have a round yellow spot on each shoulder. The head appears pointed and the hind legs have an expanded area that superficially resembles a leaf, hence its name.

In late spring to early summer, leaffooted bug enter pomegranate orchards to feed on newly developing fruit and reproduce. Females lay brown, tube-shaped eggs on twigs. Once hatched, nymphs develop to adults in 6 to 8 weeks. Because the adults are long-lived and can lay eggs over an extended period of time, the population consists of all life stages by late June. In September, females begin laying large numbers of eggs and as those offspring develop, they form aggregations on fruit and vegetation ranging in size from tens to several hundred individuals. By late November, newly developed adults leave pomegranate and form overwintering aggregations on more sheltered plants such as citrus, juniper, cypress, and palm trees.

Throughout the fall, adult and nymph leaffooted bugs feed on the fruit and during mild winters may remain in the orchard through mid-March. Pomegranate orchards with cracked and split fruit left on the trees are a favored overwintering site.

Cold winters can kill many overwintering adults; however, it requires a low of approximately 21ºF for at least six hours to kill about 50% of the exposed population. Outbreaks can occur after several years of moderate winters, which allow numbers to increase.

Adults are strong flyers and can quickly move into and within the orchard. In the spring, they can be found in the orchard and also migrating out of the orchard to nut crops such as almond (March and April) and pistachio (April and May). During the late summer and early fall, leaffooted bugs may migrate to citrus.

DAMAGE

Leaffooted bugs can build up to very large numbers in pomegranate orchards from mid-August through harvest. Due to their aggregation behavior, it is not uncommon to find more than 100 nymphs on a single piece of fruit.

Feeding damage is not easy to see on the outside of the fruit. If the fruit are cut open, brown spots can be seen on the inside of the skin where the insect's proboscis penetrated. Feeding on the aryl can cause them to wither. Minor feeding by leaffooted bug typically goes unnoticed in the packinghouse and is not offgraded. However sometimes, opportunistic pathogens enter the fruit through feeding wounds and cause soft rot on the fruit surface or black rotten areas within the fruit.

MANAGEMENT

An occasional adult leaffooted bug on fruit is tolerable, but numbers should not be allowed to build. Remove all fruit before winter to decrease the number of overwintering bugs. Native egg parasites, such as *Gryon pennsylvanicum*, if not disrupted, also help keep numbers down. Outbreaks, especially in late summer or fall before harvest, should be treated quickly, before serious damage can occur.

Biological Control

The egg parasite, *Gryon pennsylvanicum*, provides partial to good control of leaffooted bugs, especially if host numbers are high. Eggs with round exit holes indicate presence of the parasite.

Cultural Control

Remove all fruit before winter to reduce the number of leaffooted bugs overwintering in an orchard. Cleaning debris from near the orchard may also help. Cold temperatures near 21°F (-6°C) will kill some exposed bugs, while those protected from winter weather survive better. If possible, remove other nearby overwintering hosts such as juniper. It is not known if efforts to reduce leaffooted bug populations after harvest has a direct benefit to the pomegranate orchard the following August. However, winter sanitation in pomegranates is very important in pomegranate orchards next to preferred spring hosts, such as almonds.

Organically Acceptable Methods

Where possible, manage leaffooted bugs in neighboring crops to prevent migration into pomegranate. Use cultural controls to reduce overwintering numbers. Pyrethrins may kill some nymphs but control efficacy varies.

Monitoring and Treatment Decisions

Leaffooted bug outbreaks occur areawide so if problems are observed in almonds or pistachios, also look for them in pomegranates. Be wary after mild winters, or if high numbers were found the previous fall. Scout orchards for individual adults or masses of nymphs on fruit from mid-August through October. Higher numbers will be found closer to harvest.

There are no treatment thresholds for leaffooted bugs in pomegranates.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table****. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*			
A. CLOTHIANIDIN (Belay) MODE-OF-ACTION GROUP NUMBER[1]: 4A COMMENTS: Do not apply during bloom. Review and follow the California neonicotinoid regulations effective January 1, 2024. Application of this insecticide is prohibited if managed pollinators will be used during the growing season. The use of multiple application methods or neonicotinoid active ingredients affected may also be prohibited.	4–6 fl oz	12	7
B. METHOMYL* (Lannate SP) MODE-OF-ACTION GROUP NUMBER[1]: 1A COMMENTS: Disruptive to natural enemies of mealybugs, caterpillars, soft scales, aphids, and other pests. Use of this pesticide may result in outbreaks of these pests. Methomyl is also toxic to bees and should not be applied when bees are actively foraging.	1 lb	48	14
C. PYRETHRINS (PyGanic EC 1.4)# MODE-OF-ACTION GROUP NUMBER: 3A	2–4 pt	12	When dry

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases, the REI exceeds the PHI The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers ("un"=unknown or uncertain mode of action) are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

\# Acceptable for use on organically grown produce.

NAVEL ORANGEWORM AND CAROB MOTH (12/18)

Scientific names
Navel orangeworm: *Amyelois transitella*
Carob moth: *Ectomyelois ceratoniae*

DESCRIPTION OF THE PESTS

Navel orangeworm and carob moth have similar behavior and look almost identical. Adult moths have a snoutlike projection at the front of the head. Moths can have silver and black forewings and legs or wings can be cinnamon brown and black.

About two nights after emergence, females begin laying eggs next to wounds or rotten spots in the fruit. Newly hatched larvae are reddish orange and later vary from milky white to pink with a reddish-brown head capsule. Distinguish both navel orangeworm and carob moth larvae from similar looking caterpillars such as oriental fruit moth by looking for a pair of crescent-shaped markings on the second segment behind their head. Pupae are light to dark brown, encased in a woven cocoon in the fruit or calyx. There are three to four adult flight periods per year. The larvae overwinter in old fruit, either in trees or on the ground.

The pupal stage is the best time to differentiate the carob moth from the navel orangeworm. Carob moth pupae have a raised dark ridge near the head and two short spines on each abdominal segment, which are lacking in the navel orangeworm.

DAMAGE

Navel orangeworm and carob moth rarely attack healthy pomegranate fruit, but if numbers are high, such as for orchards near almonds or pistachios, damage can be serious. So far, damage has only been reported in early varieties such as Early Foothill. In adjacent Wonderful orchards, only occasional damage has been noted.

Moths prefer to lay eggs on damaged fruit; larvae typically enter through cracks, rotten spots, or wounds caused by other pests such as omnivorous leafroller. However, larvae hatching from eggs laid on the seam where two calyx petals touch have been observed entering the calyx. Feeding inside the calyx sometimes leads to rot.

Navel orangeworm and carob moth produce more silk and frass than leafrollers and may be found with more than one worm in the same feeding tunnel. Neither navel orangeworm nor carob moth is common in pomegranates.

MANAGEMENT

Remove unharvested fruit from the trees and disc into the soil to reduce overwintering moth numbers and prevent populations from establishing.

Monitor flights with pheromone lures. Egg traps can also be used; place them out in the orchard the first week of April.

1. Use black egg traps baited with almond presscake filled half- to three-quarters-full. Change bait every 4 weeks.
2. Place 1 trap per every 10 acres, for at least 4 traps per orchard. Choose trees that are at least 5 trees in from the edge of the orchard. Hang traps at head height on the north side of trees.
3. Monitor traps, counting and recording egg numbers. Remove eggs as you monitor.

In orchards with high moth numbers or a history of damage, apply an insecticide during egg hatch before fruit ripening. Use an insecticide with a long residual during hatching, activity against adult moths, or both.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table****. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
A. CHLORANTRANILIPROLE (Altacor)	3–4.5 oz	4	1
MODE-OF-ACTION GROUP NUMBER[1]: 28			
B. METHOXYFENOZIDE (Intrepid 2F)	8–16 fl oz	4	7
MODE-OF-ACTION GROUP NUMBER[1]: 18			
C. SPINETORAM (Delegate WG)	6–7 oz	4	1
MODE-OF-ACTION GROUP NUMBER[1]: 5			
COMMENTS: Highly toxic to bees. Do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
D. SPINOSAD (Entrust)#	1.25–2.5 oz (0.45–0.83 oz/100 gal)	4	7
MODE-OF-ACTION GROUP NUMBER[1]: 5			
COMMENTS: Highly toxic to bees. Do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
E. BACILLUS THURINGIENSIS ssp. KURSTAKI# (various products)	Label rates	4	0
MODE-OF-ACTION GROUP NUMBER[1]: 11A			
COMMENTS: Least harmful to natural enemies. *Bacillus thuringiensis* is a stomach poison and must be consumed. It must be applied when larvae are small. A second or third spray may be required. It is most effective if applied when weather forecasts predict 3 to 4 days of warm, dry weather. Larvae are more active and feed more in warm weather than in cooler or rainy weather.			
F. METHOMYL* (Lannate SP)	1 lb	48	14
MODE-OF-ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Disruptive to natural enemies of mealybugs, caterpillars, soft scales, aphids, and other pests. Use of this pesticide may result in outbreaks of these pests. Methomyl is also toxic to bees and should not be applied when bees are actively foraging.			

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases, the REI exceeds the PHI The longer of two intervals is the minimum time that must elapse before harvest.

\# Acceptable for use on organically grown produce.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

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OMNIVOROUS LEAFROLLER (12/18)

Scientific name: *Platynota stultana*

DESCRIPTION OF THE PEST

Omnivorous leafroller can be a significant pest. The larvae are cream colored with black or brown head capsules and resemble other leafrollers, except that they have white tubercles at the base of each bristle along the top of the abdomen. Omnivorous leafrollers are more common in interior valleys and Southern California mountain orchards, especially those next to vineyards, than in orchards in coastal areas or at higher elevations of the Sierra Foothills. Orchards may be invaded by omnivorous leafroller moths that develop on host plants outside the orchard. Infestations are often spotty, making monitoring difficult. They have three to four generations per year.

The adult omnivorous leafroller is bell-shaped with blackish gray snoutlike mouthparts that protrude forward from the head. Forewings are dark, rusty brown with a tan tip. Size varies from 0.38 to 0.5 inch (9.7–12.7 mm). Omnivorous leafroller larvae overwinter in weeds. In spring, larvae complete their development, and moths emerge and lay shinglelike egg masses on leaves, which hatch after about 5 days. The larva does not roll leaves as its name suggests. Instead, it weaves a silk nest between two leaves, a leaf and a fruit, or where two fruit touch.

DAMAGE

On pomegranates, the larvae typically carve surface grooves where two fruit touch or where the larvae have tied a leaf to the fruit surface. Often the larvae tunnel into the fruit. If skin penetration occurs, pathogens may become established internally and grow on the arils with no visible, external symptoms. If the fruit is not culled before juicing, the product may be ruined.

MANAGEMENT

Insecticide sprays timed according to degree-day accumulations may be used. Mating disruption can be effective if started in February or early March when moths first fly. A second hanging of dispensers may be needed in late summer. Careful monitoring, including occasional fruit and foliage inspections, is critical to the success of these management tools.

Biological Control

More than 10 species of parasites have been recorded from omnivorous leafroller. However, seldom does mortality from these parasites exceed 10%. Predators such as lacewings, minute pirate bugs and spiders also feed on omnivorous leafroller larvae that are feeding on leaves. Biocontrol does not provide control of larvae that have entered fruit.

Cultural Control

During the first flight, adults oviposit on weed hosts near the orchards, so weed control early in the season reduces the second generation that may cause damage to pomegranate orchards. Manage orchard weeds during late winter. Disc clusters and weeds to bury overwintering larvae living on weeds in ground duff. During dormancy, prune out old fruit and destroy by flailing or shredding.

Organically Acceptable Methods

Applications of *Bacillus thuringiensis*, spinosad (Entrust), and the use of mating disruption are organically acceptable.

Monitoring and Treatment Decisions

- Monitor omnivorous leafroller adults with a minimum of 2 traps per block first placed in orchards at 5 to 6 feet high in the canopy around February 15 to 20.
- For blocks over 20 acres use an additional 1 trap per 20 acres.
- Check the traps at least one to two times per week until the first consistent moth catch (the biofix date).

A treatment threshold based on trap moth catches has not been established. However, traps can be used to time a pesticide application.

Mating Disruption

If mating disruption is to be used, place pheromone dispensers out in February to early March or at the biofix. To ensure coverage through the long growing season, a second hanging of dispensers may be needed in the late summer (July). In some orchards, putting dispensers out once in mid-May, before the second-generation moth flight begins, can provide control.

Pheromone dispensers will disrupt pheromone trap catches. Several times throughout the season, inspect foliage and fruit for leafrollers and damage to confirm that mating disruption is working. Several moths in traps can be an indication that pheromone disruption is not working.

Insecticides

Timing insecticides using degree-days in pomegranate has not been studied but should resemble the timings that are used in stone fruits. Apply an insecticide about 700 to 900 degree-days (lower development threshold 48°F, upper threshold 87°F) after the first flight. If applying *Bacillus thuringiensis*, timing must be precise since *Bacillus thuringiensis* must be ingested to work and is most effective against small larvae. *Bacillus thuringiensis* has a short residual, should be applied twice about 7 to 10 days apart, is slow acting, and may not reduce numbers quickly.

Continue monitoring trap catches weekly until the second-generation flight, about 1200 degree-days after the first flight in late June, treating 700 to 900 degree-days after the first flight.

The third generation, in late July or early August, is most damaging to fruit. If earlier control measures were adequate, additional third generation measures should not be necessary, but if pheromone traps or fruit inspections indicate a continuing problem, additional sprays can be aimed at the third moth flight 700 to 900 degree-days after the flight begins. However, no insecticide is effective against larvae that have already entered the fruit.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table****. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*

A.	CHLORANTRANILIPROLE (Altacor) MODE-OF-ACTION GROUP NUMBER[1]: 28	3–4.5 oz	4	1
B.	SPINETORAM (Delegate WG) MODE-OF-ACTION GROUP NUMBER[1]: 5 COMMENTS: Highly toxic to bees. Do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.	4–7 oz	4	1
C.	METHOXYFENOZIDE (Intrepid 2F) MODE-OF-ACTION GROUP NUMBER[1]: 18	8–16 fl oz	4	7
D.	METHOMYL* (Lannate SP) MODE-OF-ACTION GROUP NUMBER[1]: 1A COMMENTS: Disruptive to natural enemies of mealybugs, caterpillars, soft scales, aphids, and other pests. Use of this pesticide may result in outbreaks of these pests. Methomyl is also toxic to bees and should not be applied when bees are actively foraging.	1 lb	48	14
E.	SPINOSAD (Entrust)# MODE-OF-ACTION GROUP NUMBER[1]: 5 COMMENTS: Highly toxic to bees. Do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.	1.25–2.5 oz (0.45–0.83 oz/100 gal)	4	7
F.	BACILLUS THURINGIENSIS ssp. KURSTAKI#			

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
(various products)	Label rates	4	0
MODE-OF-ACTION GROUP NUMBER[1]: 11A COMMENTS: Least harmful to natural enemies. *Bacillus thuringiensis* is a stomach poison and must be consumed by the leafroller. Must be applied when larvae are small. A second or third spray may be required. Most effective if applied when weather forecasts predict 3 to 4 days of warm, dry weather. Larvae are more active and feed more in warm weather than in cooler or rainy weather.			
G. MATING DISRUPTANTS			
(Checkmate OLR)#	100–150 units	—	—

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases, the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

\# Acceptable for use on organically grown produce.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

— Not applicable.

* Permit required from county agricultural commissioner for purchase or use.

SOFT SCALES (12/18)

Scientific names
Citricola scale: *Coccus pseudomagnoliarum*
Black scale: *Saissetia oleae*
Brown soft scale: *Coccus hesperidum*
European fruit lecanium: *Parthenolecanium corni*

DESCRIPTION OF THE PESTS

Hot temperatures during crawler development in the spring typically limit population growth. Therefore, scales are rarely found in orchards and are only occasional pests. Citricola scale, black scale, brown soft scale, and European fruit lecanium are all soft scales found on pomegranate.

Citricola Scale

Citricola scale can be confused with brown soft scale, but coloring and the number of generations distinguish them. Citricola scale adults are grey, while brown soft scale adults are yellow to brown. Citricola scale has one to two generations per year and so at any time during the year most individuals on leaves will be near the same stage. Brown soft scale has multiple generations per year and so all stages can be present at the same time.

Crawlers of the citricola scale appear in June and July. They settle primarily on the underside of leaves, with a few on fruit. Young scales are flat and almost translucent. On fruit, they grow quickly, maturing in late July and August and producing a partial second generation of crawlers. On leaves, they grow slowly over the course of the summer and fall, molting only twice. A few may mature on the leaves, but most turn a mottled dark brown color and migrate to twigs or under the bark of the trunk in November. They complete their life cycle the following spring, reaching maturity on twigs in April or May and laying eggs. In citrus, each female may produce 1,000 to 5,000 eggs, but the number of eggs laid in pomegranates is not known.

Black Scale

Black scale adult females are about 0.2 inch (5 mm) in diameter and dark brown or black, with a prominent H-shaped ridge on the back. In San Joaquin Valley orchards, immature black scales overwinter under the bark on trunks and reach maturity there around mid-May. They reproduce without mating and lay 1,000 to 2,000 pink eggs over a period of two months. Eggs are laid under the scale's cover and have been observed in May and June. After about a week, the tiny yellow to orange crawlers hatch and move around for a day or two before settling to feed on the trunk under the bark. Immature scales retain barely visible legs through two molt cycles and are able to move slowly. After the second molt, young scales migrate to twigs or fruit. There they grow rapidly, becoming nearly circular, with leathery dark mottled gray covers and the developing H-shaped ridge. Once egg laying starts, the covers become harder and darker and the H-shaped ridge often disappears.

The second generation matures and produces eggs from mid-July through August or later. After hatching, crawlers settle and are partially grown before winter.

Brown Soft Scale

Brown soft scale looks similar to citricola scale. The coloring and number of generations distinguish them apart. Brown soft scale adults are yellow to brown, while citricola scale is gray. Brown soft scale has multiple generations so that all stages may be present at the same time versus citricola scale, which only has one or two generations per year.

The seasonal history of brown soft scale has not been studied on pomegranates. On citrus there are three to five overlapping generations a year, with numbers usually highest from midsummer to early fall, developing on twigs, leaves, and fruit.

By early August scales are found on fruit, where they reach maturity and begin laying eggs. Female brown soft scales are somewhat flattened, yellow or dark brown, and lay a few eggs at a time. Eggs hatch almost immediately and crawlers start to feed. Young scales move around until they are about half grown. They have mottled, yellowish, rounded covers. The immature scales molt twice and reach maturity on leaves, twigs, or fruit.

European Fruit Lecanium

This scale has two generations a year. It overwinters as a nymph on twigs and small branches. In spring it grows rapidly, becomes convex, and forms a shiny brown cover about 0.25 inch (6 mm) in diameter with several ridges

along the back. In late spring females lay many eggs, which fill the entire space beneath their cover, and die after egg production.

Newly hatched nymphs, or crawlers emerge from beneath the scale cover from late May through June and settle mostly on the underside of leaves. In late July through early August they migrate to the fruit.

Scale	Immature	Adult	Number of generations
Citricola scale	Mottled yellow brown	Somewhat flattened, grey	One to two (all the same development stage)
Black scale	Mottled dark grey to black with H-shaped ridge present or developing	Bulbous, black, may have H-shaped ridge	Two (all the same development stage)
Brown soft scale	Rounded, mottled yellow or brown	Somewhat flattened yellow or dark brown, smaller than citricola scale	Several (different development stages present at the same time)
European fruit lecanium	Brown	Domed, shiny brown with several ridges along the back	Two (all the same development stage)

DAMAGE

The most important economic damage from all four soft scales is the light-colored spot left when a scale is removed from a fruit, where the scale has blocked sunlight and prevented fruit coloring. If a fruit has more than one or two such spots, the fruit may be downgraded in quality.

Multiple scales on a fruit have been observed more frequently with brown soft scale than the other three species. Citricola scale stays on leaves once settled, and a 20 to 30% leaf infestation translates to only a 2 to 4% fruit infestation, usually with only one scale per fruit. Black scale has an affinity for twigs, and typically settles on the stem just above a fruit. However, black scale can settle on fruit and will sometimes reach economically damaging levels. The scales that reach maturity on fruit in August and September will produce crawlers, but the new scales will not grow large enough to be noticed at harvest.

The harmful honeydew and sooty mold associated with these soft scales in citrus and olives has not been observed on pomegranates. On pomegranates, late second instars of all four species on twigs and fruit typically produce a discrete pile of sugar, rather than a diffuse scattering of honeydew. The sugar does not grow sooty mold and is easily brushed off during harvest and packing. The extreme densities of younger stages on the leaves, often observed in citrus and olives, have not been seen on pomegranate. Ants may also help by cleaning honeydew off of leaves and fruit. Heavy honeydew and sooty mold in pomegranates is typically caused by aphids, whiteflies, or cherry leafhoppers.

MANAGEMENT

Hot weather and natural enemies keep soft scales below economically significant levels in most years in most orchards. In olives, pruning to keep trees open usually keeps black scale numbers low. This is probably true in pomegranates also, and for the other scale species.

If pesticide applications are necessary, the most effective timing for these applications is June through July, when young stages are exposed on leaves and fruit, before they grow large enough to be harmful. In August, potential scale damage becomes more evident (monitoring of young scale is difficult) and can be managed using pesticide applications.

Biological Control

Soft scale natural enemies have not been identified in pomegranates, but they presumably are some of the same species that attack soft scale in other crops. Parasites play a leading role, and some parasites attack more than one species. The primary parasites include *Metaphycus* and *Coccophagus*.

On pomegranates, parasitism close to 100% has been observed in September for brown soft scale on fruit, where numbers are reaching economic levels. If pesticide applications are avoided, scale numbers the following year are very low. Parasitism of citricola scale on fruit is also common, but little or no parasitism of citricola on leaves has

been observed. Parasitism of black scale and European fruit lecanium has been observed, but the parasites have not been identified. In other crops, lecanium parasites are common but do not result in control of European fruit lecanium.

Specialized scale-feeding lady beetles include *Chilocorus*, *Hyperaspis*, and *Rhyzobius* species, and along the south coast, the steelblue lady beetle (*Halmus chalybeus*). Lady beetles can easily be overlooked because many are tiny, colored and shaped like scales, or (as small larvae) feed beneath the scale body.

Lacewings, predaceous bugs, and predatory mites are among the other invertebrates that at least occasionally feed on scales.

Controlling ants that interfere with parasites and predators will improve natural enemy activity, but an ant-free orchard is not necessary for adequate biological control.

Cultural Control

Pruning to keep trees open increases parasitism and reduces black scale numbers in olives. This practice could also reduce numbers of black scale and potentially the other soft scales in pomegranates.

Organically Acceptable Methods

Biological and cultural control and botanical insecticide sprays are acceptable for use in organically managed orchards.

Monitoring and Treatment Decisions

Soft scale populations will vary considerably within each orchard, so it is important to map presence and abundance in different areas. Numbers are typically low in spring, and the scales are difficult to find on the twigs and under bark. All four species produce many crawlers in June through July, and if numbers are high, the young stages will be easy to find on leaves. Sticky tape traps can also be applied by wrapping double-sided sticky tape around small branches to catch moving crawlers. Traps should be placed when crawlers are expected and replaced weekly during this time. Secure the used trap between clear plastic and paper so you can transport it and more easily assess crawler numbers.

It is important to distinguish between the nymphs of citricola scale, black scale, brown soft scale, and European fruit lecanium, because they have different economic thresholds. Use the table to identify adults, and with practice, nymphs. The history of the orchard or the presence of old and empty scale covers may provide clues to identification.

- Do not apply insecticides for citricola scale. The presence of citricola nymphs on 20 to 30% of leaves may be tolerable. They can produce honeydew on which sooty mold grows, but they are not likely to infest fruit.
- Soft brown and black scales seem to have a greater affinity for fruit, and lower numbers may call for pesticide applications, especially if biological control has been disrupted. Past history of the orchard and careful monitoring can determine if a pesticide application is needed.
- The presence of multiple scales on a significant number of fruit at any time beginning in June will result in downgrading at harvest if no pesticide is applied. However, without careful monitoring, harmful numbers may only become evident in August, and may require a pesticide application at that time.

Buprofezin applied to the younger scale stages in June and July is the most effective treatment. Methomyl is effective on soft scales but is also harsh on parasites. Certain botanical insecticides may also help, but they have not been adequately tested.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table****. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*			
A. BUPROFEZIN (Applaud)	34.5–46.0 oz	12	14

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
MODE-OF-ACTION GROUP NUMBER[1]: 16 COMMENTS: Apply at peak of crawler hatch. Good coverage is essential.			
B. FLUPYRADIFURONE (Sivanto Prime) MODE-OF-ACTION GROUP NUMBER[1]: 4D	10.5–14 fl oz	12	7
C. IMIDACLOPRID (systemic) (Admire Pro) MODE-OF-ACTION GROUP NUMBER[1]: 4A COMMENTS: Do not apply prebloom (during bud elongation; March–April) or during bloom (May–August). Do not apply when fruit is present (June–October). Apply systemic imidacloprid via chemigation. Review and follow the California neonicotinoid regulations effective January 1, 2024. Application of this insecticide is prohibited if managed pollinators will be used during the growing season. The use of multiple application methods or neonicotinoid active ingredients affected may also be prohibited.	7–14 fl oz	12	0
D. METHOMYL* (Lannate SP) MODE-OF-ACTION GROUP NUMBER[1]: 1A COMMENTS: Disruptive to natural enemies of mealybugs, caterpillars, soft scales, aphids, and other pests. Use of this pesticide may result in outbreaks of these pests. Methomyl is also toxic to bees and should not be applied when bees are actively foraging.	1 lb	48	14
E. MINERAL OIL (PureSpray Green)# MODE OF ACTION: Contact including smothering and barrier effects.	See label	4	0
F. ROSEMARY OIL/PEPPERMINT OIL (Ecotrol EC)# MODE OF ACTION: Contact including smothering and barrier effects. COMMENTS: Volumes up to 100, 150, and 200 gallons/acre, use 4, 5, and 6 pints/acre respectively.	2–6 pt	0	0
G. NEEM OIL (Trilogy)# MODE OF ACTION: — (a botanical insecticide)	1–2%	4	0

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases, the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

* Permit required from county agricultural commissioner for purchase or use.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers ("un"=unknown or uncertain mode of action) are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

— Not applicable.

\# Acceptable for use on organically grown produce.

WHITEFLIES (12/18)

Scientific names
Ash whitefly: *Siphoninus phillyreae*
Sweetpotato whitefly: *Bemisia tabaci*

DESCRIPTION OF THE PESTS

Ash whitefly is commonly found in orchards and may cause damage if not quickly controlled by parasites. Sweetpotato whitefly may become a problem if orchards are bordered by other crops such as cotton or melon, where sweetpotato whitefly is a serious pest. Whitefly adults are tiny (0.06 inch, 1.5 mm long), yellowish insects that derive their name from the white wax covering their wings and body.

While the adults of different species are similar in appearance, the immature stages are more distinctive. The last nymphal stage, often called the pupa or the red-eye nymph, is the stage that is easiest to identify. Ash whitefly pupae have a covering of dense longitudinal wax tufts on the back and short tubercular structures around the edge that exude a glassy wax. Sweetpotato whitefly pupae are oval, whitish, and soft. The edge of the pupa tapers down to the leaf surface and has few to no long, waxy filaments around the edge.

Whiteflies are found mostly on the undersides of leaves. The tiny, elongated eggs hatch into a mobile first stage immature that has legs and antennae. Both legs and antennae are lost after the first molt and subsequent stages remain fixed to the leaf surface. The adults fly readily when leaves are disturbed.

DAMAGE

Both the ash whitefly and sweetpotato whitefly occur on pomegranates in California, but ash whitefly is more common. Whiteflies sometimes reach nuisance levels, depositing honeydew on leaves and fruit. If orchards border cotton, such as in Kern County, the sweetpotato whitefly may migrate into pomegranates in July and August in such large numbers that severe damage may result from honeydew and sooty mold.

MANAGEMENT

Parasites control low to moderate infestations in most orchards, particularly for ash whitefly. However pesticide applications may be necessary.

Biological Control

The parasite *Encarsia inaron* is the most effective biological control agent of ash whitefly. Generalist predators such as lacewings and lady beetles will prey on whiteflies, but are not as reliable at reducing whitefly numbers as parasites.

Check for parasite presence by looking with a hand lens for dark parasitized pupae, empty pupae with round exit holes, and adult parasites. If parasites are present, expect control of whiteflies in a few weeks.

Monitoring and Treatment Decisions

Whiteflies are present at any time of year, but they tend to reach high numbers in July and August. Watch for the tiny, fluttering adults, for the nymphs and pupae on the undersides of leaves, and for honeydew and sooty mold on fruit and leaves. Check also for the presence of parasites.

Treat in late summer or early fall only if numbers are threatening economic damage due to sooty mold and parasites are not adequate for control. In this case, whiteflies can be controlled with buprofezin, foliar imidacloprid (fall only), or soft chemicals with short residuals such as neem (Trilogy).

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey bees, and the environment are at the top of the table****. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Always read the label of the product being used.*

A.	SPIROTETRAMAT (Movento) MODE-OF-ACTION GROUP NUMBER[1]: 23	8–10 fl oz	24	1
B.	BUPROFEZIN (Applaud) MODE-OF-ACTION GROUP NUMBER[1]: 16 COMMENTS: Apply at early nymph threshold. Good coverage is essential.	12–34.5 oz	12	14
C.	IMIDACLOPRID (foliar) (Admire Pro) MODE-OF-ACTION GROUP NUMBER[1]: 4A COMMENTS: Can be disruptive to natural enemies. Do not apply prebloom (during bud elongation; March–April) or during bloom (May–August). Do not apply when fruit are present (June–October). Review and follow the California neonicotinoid regulations effective January 1, 2024. Application of this insecticide is prohibited if managed pollinators will be used during the growing season. The use of multiple application methods or neonicotinoid active ingredients affected may also be prohibited.	2.8 fl oz	12	7
D.	METHOMYL* (Lannate SP) MODE-OF-ACTION GROUP NUMBER[1]: 1A COMMENTS: Disruptive to natural enemies of mealybugs, caterpillars, soft scales, aphids, and other pests. Use of this pesticide may result in outbreaks of these pests. Methomyl is also toxic to bees and should not be applied when bees are actively foraging.	1 lb	48	14
E.	NEEM OIL (Trilogy)# MODE OF ACTION: — (a botanical insecticide)	1–2%	4	0

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases, the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers ("un"=unknown or uncertain mode of action) are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

— Not applicable.

* Permit required from county agricultural commissioner for purchase or use.

Diseases

(Reviewed 12/18)

ALTERNARIA FRUIT ROT (BLACK HEART) (12/18)

Pathogens

Alternaria alternata and *A. arborescens*

SYMPTOMS AND SIGNS

Alternaria fruit rot infections commonly begin in the orchard following rain during flowering and early fruit development. The fungus can grow inside the fruit without external decay symptoms. Infected fruit generally are lighter in weight and the rind may be slightly off-color, such as a paler red, and may show some brownish-red discoloration. In the later stages of infection, arils show a brown decay andblack sporulation can be seen inside the fruit In advanced stages of internal decay, the fruit's exterior shows some shriveling.

COMMENTS ON THE DISEASE

Alternaria alternata and related species commonly present on plant surfaces and in dying or dead tissue of plants. The pathogens overwinter on plant debris in or on the soil and in mummified fruit. The spores are airborne and can be carried to the flowers or wounded fruit with soil dust. Infections may also start from insect and bird punctures on fruit. While San Joaquin Valley research suggests that the petal fall stage is the most susceptible to infection, infection can occur throughout the bloom and fruit development periods.

Estimated losses are usually less than 1% but can be up to 6%.

MANAGEMENT

Because the fruit crown covers the blossom tissues, preharvest sprays are generally ineffective. Cultural controls can help manage alternaria fruit rot:

- Use good orchard management practices, such as dust control and sanitation (removal of old fruit and dead branches), to reduce the incidence of the disease.
- Consider gently shaking the tree at the time of harvest to drop infected, healthy-appearing fruit to the ground.
- Avoid water stress and overwatering that may result in fruit cracking.
- Avoid packing diseased fruit by thoroughly sorting and grading pomegranates for discoloration and cracking.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least likely to cause resistance are at the top of the table****. When choosing a pesticide, consider information relating to the pesticide's properties and application timing, honey bees, and environmental impact. Always read the label of the product being used.*			
A. POLYOXIN D ZINC SALT (Ph-D) MODE-OF-ACTION GROUP NUMBER[1]: 19 COMMENTS: A chitin biosynthesis inhibitor, which has medium resistance potential.	6.2 oz	4	0

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases, the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of action (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to a fungicide with a different mode-of-action group number.

ASPERGILLUS FRUIT ROT (12/18)

Pathogen: *Aspergillus niger*

D-PM-ANIG-FR.001

SYMPTOMS AND SIGNS

Aspergillus rot infections begin most commonly in the orchard following rain during flowering and early fruit development. The fungus may grow inside the fruit without external symptoms, but external decay symptoms are more commonly seen with Aspergillus fruit rot than with Alternaria fruit rot. External decay is usually close to the calyx of fruit, with the rind of the fruit slightly off-color (e.g., paler red) and may show some yellowish to brownish-red discoloration. Inside the fruit there is black powdery sporulation and a brownish decay of the arils. Black sporulation may also show on the rind and on the cracks of the fruit.

COMMENTS ON THE DISEASE

Colonization by *Aspergillus niger* is often associated with insect infestations, such as feeding by hemipterans, or other factors that cause fruit injury or cracking (e.g., bird pecking, sunburn, overwatering, and russeting). The pathogens overwinter in plant debris, in or on the soil, and in mummified fruit. Airborne spores can be carried into fruit wounds with soil dust.

MANAGEMENT

Because the fruit crown covers the blossom tissues, the use of preharvest sprays are generally ineffective.

- Use good orchard management practices, such as dust control and sanitation (removal of old fruit and dead branches), to reduce the pre- and postharvest incidence of disease.
- Control insect pests such as filbertworm, leaffooted bugs, and carob moth that feed on the fruit, enabling pathogen entry.
- Gently shake the tree at the time of harvest to drop infected, but healthy-appearing, fruit to the ground.
- Avoid water stress and over watering that may result in fruit cracking.
- Thoroughly sort and grade pomegranates for discoloration and cracking to reduce the chance of packing diseased fruit.

BLUE/GREEN MOLD (12/18)

Pathogens: *Penicillium* spp.

D-PM-PSPP-FR.003

SYMPTOMS AND SIGNS

Blue mold can sometimes be found on fruit in the field, but it generally appears during storage. Occasionally blue mold can develop along the black heart symptoms. Initial symptoms include water-soaked areas on the outer fruit surface. Later, a green to blue-green powdery mold may develop on the surface of the lesions. Infected areas are tan or gray when cut. In advanced stages, infected arils may disintegrate into a watery rot.

COMMENTS ON THE DISEASE

Several species of *Penicillium* can cause blue mold. These fungi are common saprophytes on plant debris and senescent plant tissue. Invasion of pomegranate fruit can occur through wounds or bruises, but colonization usually occurs on the surface of senescent fruit. At advanced stages, the mycelium grows inside the fruit through the connective tissue and arils. Optimum conditions for *Penicillium* spp. development include moderate temperatures of 70° to 77°F (21°–25°C) and high relative humidity.

MANAGEMENT

Good orchard management practices, such as dust control and sanitation (removal of old fruit and dead branches), can reduce the postharvest incidence of the disease. Prevent insect damage and avoid wounds to fruit. Harvest and handle fruit with a minimum of bruising or wounding.

Storing pomegranates properly can help avoid further decay:

- The optimal postharvest storage temperature for pomegranates is 41°F (5°C) for up to two months and 45°F (7°C) for longer than two months.
- Store at 90 to 95% relative humidity.
- If storing for longer than three months, a controlled atmosphere of 5% oxygen plus 15% carbon dioxide is suggested.

CONIELLA STEM CANKER AND FRUIT ROT (12/18)

Pathogen: *Coniella (=Pilidiella) granati*

SYMPTOMS AND SIGNS

Coniella granati causes stem and crown cankers, resulting in decline and eventual death of young pomegranate shoots. Fruit decay may occur in the field and postharvest.

Infection turns the arils brown and juicy. Fruit membranes and the rind also turn brown. Black fungal pycnidia with characteristic large, elliptical, colorless, one-celled spores can develop on the surface of the arils, membranes, and surface of the rind (fruit skin). Pycnidia can also be found in the bark of trunks, killed shoots, and thorns, as well as on the surface of leaves. Dry infected fruit left in the orchard are called mummies.

Coniella rot is very different from Alternaria fruit rot, Aspergillus fruit rot, and gray mold.

Symptoms	**Coniella stem canker and fruit rot**	**Alternaria fruit rot** (*Alternaria alternata* and other *Alternaria* spp.)	**Aspergillus fruit rot** (*Aspergillus niger*)	**Gray mold** (*Botrytis cinerea*)
Fruit symptoms	Decay of fruit rind and arils Pycnidia on fruit	Decay of fruit arils but typically not the rind (rind shrivels only in later stages of infection); arils decay: brown decay and black sporulation inside fruit	Decay of fruit rind; arils decay: brown decay and black sporulation inside and outside the fruit when decay lesions become external	Decay of fruit rind and arils; grayish mycelium Sporulates on decayed fruit
Trunk, shoot and leaf symptoms	Pycnidia on trunk, shoots, thorns, and leaves	No symptoms or signs on trunk, shoots, thorns, and leaves	No symptoms or signs on trunk, shoots, thorns, and leaves	Sporulates on dead shoots, thorns, and leaves

COMMENTS ON THE DISEASE

The pathogen is isolated frequently from pomegranates, but the disease is only sporadically found in Fresno, Madera, and Kern county orchards.

In orchards, the pathogen overwinters as pycnidia and mycelia in stem cankers and rotten fruit (mummies), pruned limbs on the ground, and desiccated leaves.

Fruit infection occurs through wounds (e.g., insect exit holes, bird pecks, thorn punctures, and natural cracking). Infections, however, can spread by contact from infected fruit to healthy fruit in packed boxes, similar to gray mold. The pathogen can also be isolated from symptomless bark of the trunk, branches, and shoots.

The optimum temperature for the pathogen's growth ranges from 25 to 30°C; the fungus grows slowly at 15°C, but does not grow at 35°C.

Losses from Coniella stem canker and fruit rot have not been estimated, since this is a new disease of pomegranate in California.

MANAGEMENT

Sanitation may reduce overwintering inoculum. Remove or burn pruned limbs and bury mummies.

GRAY MOLD (BOTRYTIS FRUIT ROT) (12/18)

Pathogen: *Botrytis cinerea*

D-PM-BCIN-FR.002

SYMPTOMS AND SIGNS

Gray mold infects flower parts at bloom time and remains quiescent (inactive) until fruit ripening. Typically, once the fruit is washed or stored at high humidity, water or condensation on the blossom end activates the fungal mycelium to begin growing. The pathogen sporulates on the flower parts and the typical grayish coating of spores develops. Eventually the crown tissue will be colonized, and the fungus will grow into the fruit tissue.

Infected fruit held in storage at high humidity often completely decays and shows the typical gray coating of spores; it may also have grayish-white mycelium and black sclerotia on the surface. Decay can also start from the stem end wound, especially if the stem is entirely removed.

COMMENTS ON THE DISEASE

Gray mold is one of the most important causes of postharvest decay in pomegranates.

Botrytis spores reside in or on the soil and on previously infected plant tissue, weeds, and old fruit left on the tree or on the orchard floor (mummies). Spores are spread by wind. Spores landing on senescent flower tissues such as stamens (anther pollen sacks and filaments) germinate and produce an infection when there is free water on the plant surface from rain, dew, fog, or irrigation. Decay develops quickly when shelf temperature is about 65° to 75°F (18°–24°C).

MANAGEMENT

The extended flowering period of pomegranates makes bloom sprays for gray mold uneconomical and the fruit crown that covers the blossom prevents the use of preharvest sprays. However, postharvest sprays can be very effective.

Good orchard management practices, such as dust control and sanitation (removal of old fruit and dead branches), will reduce the postharvest incidence of disease.

Storing pomegranates properly can help avoid further decay by disease. The optimal postharvest storage temperature for pomegranates is 41°F (5°C) for up to two months and 45°F (7°C) for longer than two months. Store at 90 to 95% relative humidity. If storing for longer than three months, a controlled atmosphere of 5% oxygen plus 15% carbon dioxide is suggested.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)
Not all registered pesticides are listed. ***The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least likely to cause resistance are at the top of the table.*** *When choosing a pesticide, consider information relating to the pesticide's properties and application timing, honey bees, and environmental impact. Always read the label of the product being used.*			
POSTHARVEST			
A. FLUDIOXONIL (Scholar)	16 oz/100 gal	NA	NA
MODE-OF-ACTION GROUP NUMBER[1]: Phenylpyrrole (12)			
COMMENTS: Liquid and dry formulations are available. For resistance management, treated culled fruit should not be returned to pomegranate orchards or other fruit crops orchards where fludioxonil is applied postharvest.			

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Preharvest interval (PHI) is the number of days from treatment to harvest. In some cases, the REI exceeds the PHI. The longer of two intervals is the minimum time that must elapse before harvest.

NA Not applicable.

Common name (Example trade name)	Amount per acre	REI‡ (hours)	PHI‡ (days)

[1] Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of action (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to a fungicide with a different mode-of-action group number.

Precautions for Using Pesticides

Pesticides are poisonous and must be used with caution. READ THE LABEL BEFORE OPENING A PESTICIDE CONTAINER. Follow all label precautions and directions, including requirements for protective equipment. Apply pesticides only on the crops or in the situations listed on the label. Apply pesticides at the rates specified on the label or at lower rates if suggested in this publication. In California, all agricultural uses of pesticides must be reported. Contact your county agricultural commissioner for further details. Laws, regulations, and information concerning pesticides change frequently. This publication reflects legal restrictions current on the date next to each pest's name.

Legal Responsibility

The user is legally responsible for any damage due to misuse of pesticides. Responsibility extends to effects caused by drift, runoff, or residues.

Transportation

Do not ship or carry pesticides together with food or feed in a way that allows contamination of the edible items. Never transport pesticides in a closed passenger vehicle or in a closed cab.

Storage

Keep pesticides in original containers until used. Store them in a locked cabinet, building, or fenced area where they are not accessible to children, unauthorized persons, pets, or livestock. DO NOT store pesticides with foods, feed, fertilizers, or other materials that may become contaminated by the pesticides.

Container Disposal

Dispose of empty containers carefully. Never reuse them. Make sure empty containers are not accessible to children or animals. Never dispose of containers where they may contaminate water supplies or natural waterways. Consult your county agricultural commissioner for correct procedures for handling and disposal of large quantities of empty containers.

Protection of Nonpest Animals and Plants

Many pesticides are toxic to useful or desirable animals, including honey bees, natural enemies, fish, domestic animals, and birds. Crops and other plants may also be damaged by misapplied pesticides. Take precautions to protect nonpest species from direct exposure to pesticides and from contamination due to drift, runoff, or residues. Certain rodenticides may pose a special hazard to animals that eat poisoned rodents.

Posting Treated Fields

For some materials, *restricted entry intervals* are established to protect field workers. Keep workers out of the field for the required time after application and, when required by regulations, post the treated areas with signs indicating the safe re-entry date. Check with your county agricultural commissioner for latest restricted entry interval.

Preharvest Intervals

Some materials or rates cannot be used in certain crops within a specified time before harvest. Follow pesticide label instructions and allow the required time between application and harvest.

Permit Requirements

Many pesticides require a permit from the county agricultural commissioner before possession or use. When such materials are recommended, they are marked with an asterisk (*) in the treatment tables or chemical sections of this publication.

Maximum residue levels

Before applying pesticides to crops destined for export, check maximum residue levels (MRLs) of importing country at https://globalmrl.com.

Processed Crops

Some processors will not accept a crop treated with certain chemicals. If your crop is going to a processor, be sure to check with the processor before applying a pesticide.

Crop Injury

Certain chemicals may cause injury to crops (phytotoxicity) under certain conditions. Always consult the label for limitations. Before applying any pesticide, take into account the stage of plant development, the soil type and condition, the temperature, moisture, and wind. Injury may also result from the use of incompatible materials.

Personal Safety

Follow label directions carefully. Avoid splashing, spilling, leaks, spray drift, and contamination of clothing. NEVER eat, smoke, drink, or chew while using pesticides. Provide for emergency medical care IN ADVANCE as required by regulation.