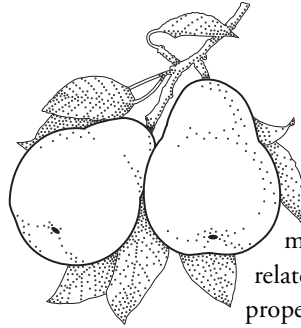


Orchard Pesticides



Fungicides and Bactericides

Several fungicides are registered for use on tree fruit, and each may be very effective against some diseases, yet have little or no effect against others. Most fungicides are effective primarily as protectants—they must be applied before infection occurs to prevent damage. Some are locally systemic and have curative activity which provides some control of infections that have already started. When developing a fungicide spray program for tree fruit in the Midwest, many things must be considered. Your state's commercial tree fruit spray guide provides

much of the information that you require related to recommended materials, rates, and proper timing, and it should be used in conjunction with this handbook. The following table summarizes general information on the fungicides currently registered for use on tree fruit. Growers should refer to product labels and the up-to-date annual spray guide for further details on rates, restrictions, timing, and application methods.

NOTE: When peach is listed in this table, it generally includes nectarines and apricots. Check the label for specific fungicides to ensure that they are labeled on that crop.

Table 14. Orchard Fungicides and Bactericides.

Trade Name	Common Name	Formulation	For Use On
Aliette	fosetyl-Al	80 WDG	Apples
	Registered for control of Phytophthora crown and root rot on apples. It is applied as a foliar spray.		
Bayleton	triadimefon	50 DG	Apples Pears
	Registered for control of powdery mildew, rust, and scab on apples. Also registered for control of powdery mildew on pears. It is a sterol-inhibiting (SI) fungicide with good activity against mildew and rust but has poor activity against scab. Where scab is a problem, it should be combined (tank-mixed) with a good scab fungicide. Has little or no activity against summer diseases.		
Benlate	benomyl	50 WP	Apples Cherries Peaches Plums
	Registered on apples for control of scab and powdery mildew. Very active against summer diseases such as sooty blotch, flyspeck, black rot, and white rot. Also registered on pears for control of scab, Fabraea leaf spot, and sooty blotch. On stone fruit, it is registered for control of brown rot, peach scab, and cherry leaf spot. Development of resistant strains of pathogenic fungi is a problem with benomyl. It should be tank-mixed with fungicides that have a different mode of action to delay resistance development. Topsin-M (thiophanate-methyl) has the same mode of action as benomyl.		
Bordeaux Mixture	copper sulfate + hydrated lime	See Comments	Apples Peaches Pears
	Recommended for use as a dormant application on apples and pears for control of fire blight. On peaches it is recommended as a dormant application for control of peach leaf curl and bacterial spot. Can cause severe injury if applied to green tissue. Due to the large volume of spray lime used to make Bordeaux mixture, it has many compatibility problems with other pesticides. Check pesticide labels for incompatibility with copper and lime.		

Table 14. *continued*

Trade Name	Common Name	Formulation	For Use On
Bravo	chlorothalonil	720 F 720 Weather Stik Bravo Ultrex	Cherries Peaches Plums
Registered for control of peach leaf curl, brown rot blossom blight, and cherry leaf spot. May not be applied after shuck-split.			
Captan	captan	50 WP, 80 WP, 4 L	Apples Cherries Peaches Plums
Registered for use on apples for control of scab and summer diseases. A good broad-spectrum protectant fungicide. Especially good for summer diseases on apples when mixed with Benlate or Topsin-M. Will not control powdery mildew or rust and is weak against flyspeck. A standard for tank-mixing with sterol-inhibiting fungicides or benzimidazoles to provide additional protectant activity and fungicide-resistance management. On stone fruit, it is registered for control of brown rot, peach scab, and cherry leaf spot. May be phytotoxic (e.g., cause shot-hole or yellowing on young peach leaves under cool, slow-drying conditions; may cause severe leaf burn on some sweet cherry cultivars such as Emperor Francis, Schmidt, and Giant). Captan should not be used on Japanese-type or Stanley plums until July, or severe shot-hole type leaf injury may occur. Captan should not be tank-mixed with sulfur, lime, or oil and should not be applied within 7 to 10 days of a sulfur, lime, or oil application.			
Carbamate	ferbam	76 WP	Apples Peaches Pears
Registered for scab and summer disease control of apples and pears, although not generally used on apples. On stone fruit, it is very effective as a dormant application for control of peach leaf curl. Late-season applications may result in unsightly black residue on fruit.			
Elite	tebuconazole	45 DF	Cherries Peaches Plums
Registered for control of brown rot blossom blight and fruit rot, powdery mildew, and cherry leaf spot. A sterol-inhibiting (SI) fungicide with locally systemic activity. For best disease control and to delay fungicide resistance, do not use below the labeled rate.			
“Fixed” copper	See comments	See comments	Apples Peaches Pears
Fixed copper materials are relatively insoluble in water compared to Bordeaux mixture and are therefore usually less injurious to plant tissues than Bordeaux mixture. However, fixed copper materials have a tendency to be phytotoxic and are often incompatible with other pesticides. Generally not recommended for use during the growing season. They are recommended as an early-season spray on apples and pears for control of fire blight. Applications beyond green tip may result in injury or harm fruit finish. On peaches, it is recommended as a dormant application for control of peach leaf curl and bacterial spot. Available in many forms and formulations.			
Indar	fenbuconazole	75 WSP	Cherries Peaches
Registered for control of brown rot blossom blight and fruit rot, peach scab, and cherry leaf spot. It also provides moderate control of powdery mildew on sour cherries. Indar is a sterol-inhibiting (SI) fungicide with locally systemic activity and is highly effective for control of brown rot.			
Mancozeb	mancozeb	80 WP, 75 DF See comments	Apples Pears
Registered for control of scab and summer diseases of apples and pears. Good broad-spectrum protectant fungicide. A standard for tank-mixing with sterol-inhibiting (SI) fungicides or benzimidazoles to provide additional protectant activity and fungicide-resistance management. May be applied at 6 lb/acre prebloom for a total of four applications, or at 3 lb/acre as a tank mix for a total of seven applications. May not be applied within 77 days of harvest. There are many trade names and formulations for mancozeb. See your state’s commercial tree fruit spray guide for additional information. Mancozeb is an EBDC fungicide.			

Table 14. *continued*

Trade Name	Common Name	Formulation	For Use On
Mycoshield	oxytetracycline	17% SP	Peaches
	Registered for control of bacterial spot on peaches. Oxytetracycline is an antibiotic. See your state's commercial tree fruit spray guide for further information.		
Nova	myclobutanil	40 WP	Apples Cherries Peaches
	Registered for control of scab, powdery mildew, and rust on apples. A sterol-inhibiting (SI) fungicide with locally systemic activity and good curative activity when used at the proper rates. Control of fruit scab on apples is increased when mixed with a broad-spectrum protectant fungicide such as captan or mancozeb. Tank-mixing also allows Nova to be used in an extended protectant program on apples. On peaches, it is registered for control of brown rot blossom blight and powdery mildew. For best disease control and to delay fungicide resistance, do not use below the labeled rate.		
Orbit	propiconazole	41.8% L	Cherries Peaches Plums
	Registered for control of brown rot blossom blight and fruit rot. A sterol-inhibiting (SI) fungicide with locally systemic activity. For best disease control and to delay fungicide resistance, do not use below the labeled rate.		
Polyram	metiram	80 WP	Apples
	Registered for control of scab, rust, and summer diseases on apples. Polyram is an EDBC fungicide and is very similar in activity and has the same use recommendations on apples as mancozeb (see mancozeb). Reported to provide good fruit finish on russet-prone varieties such as Golden Delicious. May not be applied within 77 days of harvest.		
Procure	triflumizole	50 WS	Apples
	Registered for control of scab and powdery mildew on apples and pears. A sterol-inhibiting (SI) fungicide with locally systemic activity. Procure has activity on apple similar to Nova and Rubigan. For best disease control and to delay fungicide resistance, do not use below the labeled rate.		
Ridomil	metalaxyl mefoxam	2 E Ridomil Gold	Apples Cherries Peaches Plums
	Registered for control of Phytophthora root and crown rot on apples and stone fruit trees. Ridomil may aid in control of crown and root rot when used in conjunction with good cultural practices such as improved soil drainage and rootstocks that are most tolerant to the disease. Applications should be made before symptoms are visible, especially in areas of the orchard (wet areas) that are more favorable for disease development. Ridomil will not revitalize trees showing moderate to severe crown rot symptoms. Ridomil Gold is a new formulation that will eventually replace Ridomil 2 E.		
Ronilan	vinclozolin	50 WP	Cherries Peaches
	Registered for brown rot blossom blight and fruit rot. Not registered for use on plums. A good protectant fungicide with slight locally systemic activity. A dicarboximide fungicide that has the same mode of action as Rovral. Both Ronilan and Rovral are at high risk for resistance development in the brown rot fungus. These fungicides should not be tank-mixed with each other or alternated with each other in the spray program. Preharvest use is restricted to a single spray, and it may not be applied within 14 days of harvest.		
Rovral	iprodione	50 WP, 4 L	Cherries Peaches Plums
	Registered for control of brown rot blossom blight and fruit rot on cherries, peaches, and plums, and provides moderate control of cherry leaf spot. A good protectant fungicide with slight locally systemic activity. A dicarboximide fungicide that has the same mode of action as Ronilan. Both Rovral and Ronilan are at high risk for resistance development in the brown rot fungus. These fungicides should not be tank-mixed with each other or alternated with each other in the spray program. Rovral and the related fungicide Ronilan (vinclozolin) are especially effective at inhibiting spore production by the brown rot fungus and therefore are particularly recommended in wet years that are conducive to rapid disease buildup.		

Table 14. *continued*

Trade Name	Common Name	Formulation	For Use On
Rubigan	fenarimol	1 EC	Apples Cherries Pears
<p>Registered for control of scab and powdery mildew on apples and pears, and rust on apples. A sterol-inhibiting (SI) fungicide with locally systemic activity and good curative activity when used at the proper rates. Control of fruit scab is increased when tank-mixed with a broad-spectrum protectant fungicide such as captan or mancozeb. Tank-mixing also allows Rubigan to be used in an extended protectant program on apples. Registered on cherries for control of cherry leaf spot and powdery mildew. It has poor activity against brown rot. For best disease control and to delay fungicide resistance, do not use below the labeled rate. Specifically, Rubigan should not be used at a concentration less than 3 fl oz per 100 gal. of water.</p>			
Streptomycin	streptomycin	Agri-strep Agrimycin	Apples Pears
<p>Streptomycin is an antibiotic registered for control of fire blight on apples and pears. It is a foliar spray effective during bloom. Although streptomycin is most effective when used alone, it can be tank-mixed with most other commonly used orchard insecticides and fungicides except Bordeaux mixtures or highly alkaline materials. Once absorbed into plant tissues, streptomycin is fairly stable. However, the absorption of streptomycin is reduced when used in combination with captan, dodine, or sulfur. Absorption can be improved significantly with the use of spreader-activator type adjuvants like Glyodin or Regulaid. Normally, streptomycin is used at 8 oz per 100 gal. of water, but where the above adjuvants are used, this rate can be reduced to 4 to 6 oz per 100 gal. Foliar injury may occur when streptomycin is used at the 8-oz rate with a spreader-activator adjuvant. Streptomycin is also recommended for control of blister spot on apples. In the Midwest, streptomycin-resistant strains of the fire blight bacterium have been reported in parts of Michigan and Missouri.</p>			
Sulfur	sulfur	95 WP, 6 F, Dust	Apples Cherries Peaches Plums
<p>Registered for control of scab and powdery mildew on apples. When used in a protectant schedule, it has good activity on powdery mildew and is relatively weak for scab control. On stone fruit, it is registered for control of brown rot blossom blight and fruit rot, peach scab, and powdery mildew. It is generally considered less effective for control of brown rot than captan or the "newer" brown rot fungicides. Many formulations of sulfur are available. Avoid use of sulfur at high temperatures (80° to 90°F) because of the potential for leaf injury and fruit russetting. Sulfur should not be applied with or within 7 days of captan on Red Delicious and not within 7 days before or after oil on most apple varieties.</p>			
Syllit	dodine	65 WP	Apples Cherries
<p>Registered for control of scab on apples and cherry leaf spot. Will not control powdery mildew, rust, or summer diseases on apples. Syllit-resistant strains of the apple scab fungus have been reported where the material has been used as a predominant scab fungicide for long periods of time (8 to 10 years). Syllit is particularly useful on established apple scab lesions where resistance is not present. It does not eradicate the lesion but suppresses both the production and germination of spores. When Syllit is used for this purpose, apply 3/4 lb per 100 gal. and follow with a second application 7 to 10 days later with 1/2 lb per 100 gal. However, applying Syllit to sporulating lesions greatly increases the probability of developing resistance. Syllit may cause fruit injury if applied at freezing or near-freezing temperatures, particularly if slow-drying conditions exist. Syllit may russet Golden Delicious, especially if applied during bloom, petal fall, or early cover sprays. It is compatible with oil and most fungicides formulated as wettable powders.</p>			
Thiram	thiram	65 WP	Apples Peaches
<p>Registered for control of scab, rust, and summer diseases of apples. A protectant fungicide that is not as effective for scab control as captan, mancozeb, dodine, benomyl, or thiophanate-methyl. It provides only fair control of summer diseases on apples (sooty blotch and flyspeck). Registered for control of brown rot blossom blight and fruit rot, peach leaf curl, and scab on peaches.</p>			

Table 14. *continued*

Trade Name	Common Name	Formulation	For Use On
Topsin-M	thiophanate-methyl	70 WP 4.5 F	Apples Cherries Peaches Plums
Registered on apples for control of scab and powdery mildew. Very active against summer diseases such as sooty blotch, flyspeck, black rot, and white rot. On stone fruit, it is registered for control of brown rot, peach scab, and cherry leaf spot. Development of resistant strains of pathogenic fungi is a problem with thiophanate-methyl. It should be tank-mixed with fungicides that have a different mode of action to prevent or delay resistance development. Benlate (benomyl) has the same mode of action as thiophanate-methyl.			
Ziram	ziram	76 DF	Apples Cherries Peaches Pears
Registered on apples and pears for control of scab and summer diseases and will also control rust on apples. A protectant fungicide that is not as effective for scab control as captan, mancozeb, dodine, benomyl, or thiophanate-methyl. It provides fair to good control of summer diseases when used at higher rates. On stone fruits, it is registered for control of brown rot, peach leaf curl, and scab. On peaches, it is a good alternative to captan on those peach cultivars that are subject to captan injury.			
DF = Dry flowable; DG = Dispersible granule; E = Emulsifiable; EC = Emulsifiable concentrate; F = Flowable; L = Liquid; SP = Soluble powder; WDG = Water dispersible granule; WP = Wettable powder; WS = Water soluble; WSP = Water soluble powder			

Insecticides and Miticides

Insecticides and miticides in the following list have been placed in groups according to their chemical composition. These summaries include formulations, crop site, pests for which registered, signal word, and other brief information. This information should help growers who desire to rotate from one group or class to another when pesticide resistance is suspected or to select a similar product from the same class.

Carbamate Products

Carzol (formetanate hydrochloride): This product is registered as a 92% SP for use on apple trees to control tentiform leafminer, white apple leafhopper, European red and two-spotted mites; on pears to control European red, two-spotted, and rust mites; and on peaches, plums, and prunes to control mites, lygus bugs, and stink bugs. Carzol is less effective in the summer when eggs, nymphs, and adults are equally abundant. This product is highly toxic to predator mites. Signal word: Danger—Poison.

Lannate (methomyl): This fast-acting contact insecticide, formulated as Lannate 90% WSP (in

soluble pouches) and Lannate LV (2.4 lb/gal. WSL), is registered for use on apple trees to control apple aphid, rosy apple aphid, tufted apple budmoth, green fruitworm, tarnished plant bug, codling moth, leafrollers, lesser appleworm, white apple leafhopper, tentiform leafminer, and cutworms. Use on peach trees to control cat-facing insects (plant bugs and stink bugs), oriental fruit moth, and green peach aphid. Best results follow direct spraying on target pest using fine spray droplets at low volume. Lannate provides very little residual activity. Product may be fatal or cause blindness if swallowed. Do not get in eyes, on skin, or on nonprotective clothing. Do not apply through any irrigation system. Lannate L and LV are restricted-use pesticides (RUP). Signal word: Danger—Poison.

Sevin (carbaryl): This product is usually formulated as a 50% WP. Other formulations are also available. It is a broad-spectrum insecticide that may be used on apples, peaches, nectarines, plums, prunes, and cherries. Do not apply to apple trees for insect control within 30 days of bloom since Sevin acts as a thinner on many varieties. Sevin is highly toxic to bees and should not be used near bloom. Signal

Table 15. Effectiveness of selected fungicides against apple diseases.

Fungicide	Scab	Powdery mildew	Rust	Black rot and white rot	Bitter rot	Sooty blotch	Flyspeck
Bayleton	P	E	E	O	O	O	O
Benlate*	E	E	O	G	P	E	G
Captan	E	O	O	G	E	F-G	F-G
Ferbam (carbamate)	F	O	G	F	P	F	F
Mancozeb (Dithane, Manzate, Penncozeb)	G	O	G	G	E	E	E
Nova	E	E	E	O	O	O	O
Polyram	G	O	G	G	E	E	E
Procure	E	E	E	O	O	O	O
Rubigan	E	E	E	O	O	O	O
Sulfur	F	G	O	F	-	P	P
Syllit*	E	O	P	P	O	P	P
Thiram	F	O	G	F	P	F	F
Topsin M*	E	E	O	G	P	E	G
Ziram	F	O	F	P	E	F-G	F-G

- = unknown or doesn't apply; O = none; P = poor; F = fair; G = good; E = excellent.

* Many areas of the Midwest may contain strains of the apple scab and powdery mildew fungus tolerant of these chemicals. Therefore, these fungicides may not be effective in some areas.

Table 16. Effectiveness of selected fungicides against stone fruit pathogens.

Fungicide	Brown rot						
	Blossom blight	Fruit rot	Peach leaf curl	Peach scab	Powdery mildew	Cherry leaf spot	Black knot of plum
Benlate*	E	E	-	G	F	G	F
Bravo	G	-	E	G	O	E	E
Captan	G	F-G	-	G	O	G	G
Elite	E	E	-	-	G	G	-
Ferbam	-	F	E	-	O	F	-
Fixed copper	-	-	G	-	F	G	P
Indar	E	E	-	-	G	E	-
Nova	E	-	-	-	E	E	-
Orbit	E	E	-	-	-	-	-
Ronilan	E	E	-	P	-	P	-
Rovral	E	E	-	P	-	F	-
Rubigan	-	-	-	-	G	E	-
Sulfur	F	P	-	G	G	P	O
Syllit*	-	P	-	-	O	G	-
Thiram	P-F	P-F	G	G	-	-	-
Topsin M*	E	E	-	G	F	G	F
Ziram	P-F	P-F	G	G	-	F	-

- = unknown or doesn't apply; O = none; P = poor; F = fair; G = good; E = excellent.

* Many areas of the Midwest may contain strains of the brown rot, powdery mildew, and cherry leaf spot fungi tolerant of these chemicals. Therefore, these fungicides may not be effective in some areas.

word: Caution. Low mammalian toxicity makes this product desirable for use by the general public. However, it does not provide the level of control desired by commercial growers for most pests.

Vydate (oxamyl): Vydate L is an insecticide/nematicide formulated as a 2 lb/gal. WSL used on apple trees to control spotted tentiform leafminer, European red and two-spotted mites, and white apple leafhopper. Do not apply at bloom or within 30 days after full bloom, or fruit thinning may occur. Vydate is used on pear trees to control European red, McDaniel, two-spotted, and pear rust mites. Vydate is highly toxic to predator mites. Vydate is a restricted-use pesticide. Signal word: Danger—Poison.

Chlorinated Hydrocarbon Products

Kelthane (dicofol): This miticide is registered as 35 W and 50 W formulations for use on apples and pears. It is effective against European red and two-spotted spider mites. Resistance may be a problem in some areas, so apply only once per year on apples. Rotate with other miticides to slow development of resistance. Kelthane is highly toxic to predatory mites at high rates and moderately toxic at lower rates. Signal word: Warning.

Marlate (methoxychlor): This insecticide is registered as a 50% WP for use on apple and pear trees to control apple maggot, codling moth, Japanese beetle,

plum curculio, and tent caterpillars. Marlate is used on apricot, cherry, nectarine, peach, plum, and prune trees to control cherry fruitworm, cherry fruit flies, Japanese beetle, plum curculio, rose chafer, tent caterpillar, and cankerworms. Signal word: Caution, making this product desirable for use by the general public. Methoxychlor does not provide the level of control desired by most commercial growers.

Thiodan (endosulfan): The 50% WP and 3EC formulations are registered for use on apple trees to control apple aphid, rosy apple aphid, green fruitworm, tarnished plant bug, white apple leafhopper, apple rust mite, and woolly apple aphid; and on pears for green fruitworm, tarnished plant bug, rust mite, pear blister mite, and pear psylla. Registration for apricot, nectarine, and peach trees is to control peachtree borer, lesser peachtree borer, cat-facing insects, green peach aphid, peach twig borer, and green fruitworm. Signal word: Danger—Poison.

Organo-phosphate Products

Defend and Dimethoate (dimethoate): These two products are formulated as a 2.67 lb/gal. EC systemic insecticide-miticide primarily registered on apples and pears primarily for control of sucking insects such as aphids and leafhoppers. It is also registered for apple maggot and codling moth. Do not apply when substantial numbers of weeds in the orchard are in bloom because it is highly toxic to honeybees. Signal word: Warning.

Diazinon (diazinon): This product as a 50% WP is primarily registered to control apple maggot; codling moth; green, rosy, and woolly apple aphids; and is very effective on San Jose scale crawlers. It suppresses mites but is not considered a miticide. It is also registered for control of other pests on pear, cherry, nectarine, peach, plum, and prune trees. Some formulations of Diazinon are restricted-use products. Signal word: Warning. Diazinon is moderately toxic to *Stethorous punctum* larvae and adults.

Guthion and Sniper (azinphos-methyl): Guthion is formulated as a 35% WP, and Guthion and Sniper as 50% WP water-soluble packets for use on apple trees to control apple maggot, codling moth, European

apple sawfly, eye-spotted bud moth, Forbes scale, green fruitworm, leafhoppers, leafrollers, plum curculio, San Jose scale, stink bug, and tarnished plant bug. Use on nectarines, peaches, plums, and prunes provides control of scale insects, lesser peachtree borer, mites, peachtree borer, plum curculio, stink bug, and tarnished plant bug. Registration for cherries includes use for control of eye-spotted bud moth, fruit flies, fruit-tree leafroller, lesser peachtree borer, mites, plum curculio, and scale insects. Guthion is commonly recommended in IPM programs because it is not highly toxic to mite predators. Guthion is a restricted-use pesticide. Signal word: Danger—Poison.

Imidan (phosmet): This product is registered as a 70% WP and is very effective against many fruit pests. It is used on apple trees to control apple maggot, codling moth, green fruitworm, Japanese beetle, leafrollers, plum curculio, and tarnished plant bug, and on pears for most of the same insects. On apricot, nectarine, plum, and prune trees, it controls apple maggot, oriental fruit moth, peach twig borer, plum curculio, and red-banded leafroller; on peach trees, Japanese beetles, oriental fruit moth, peach twig borer, plum curculio, and tarnished plant bug. Imidan is not effective against aphids or leafhoppers, and leafhoppers may become abundant where it is used regularly. Imidan is commonly recommended in IPM programs because it is not highly toxic to mite predators. Signal word: Warning.

Lorsban (chlorpyrifos): This product is registered as a 4 lb/gal. EC for application with spray oil as a dormant or delayed dormant spray on apple trees to control rosy apple aphid, San Jose scale, Pandemis leafroller, and climbing cutworms; on pear trees for San Jose scale, climbing cutworms, and pear psylla adults; on plum and prune trees for San Jose scale, mealy plum aphid, climbing cutworms, and peach twig borer; and on peach, nectarine, and cherry trees to control San Jose scale, peach twig borer, and climbing cutworms. Lorsban 4E is also registered to control peachtree borers as a tree trunk application made before newly hatched borers enter the trees, and also on cherry trees to control lesser peachtree borer, peachtree borer, and American plum borer. Follow specific instructions on label for timing. There is a

limit of one application per season. The 50% WP is registered for full-season general insect control and is effective against aphids, apple maggot, codling moth, green fruitworm, leafrollers, periodical cicada, plum curculio, San Jose scale, woolly apple aphid, and dogwood borer. Make no more than eight applications per season. Lorsban may cause russetting on Golden Delicious. Signal word for both formulations: Warning.

Malathion (malathion): This general-use product is formulated as a 57% EC, 25% WP, and 50% WP and is labeled for use to control aphids, codling moth, leafhoppers, leafrollers, mites, plum curculio, and San Jose scale. It is not effective for mite control in orchards where mites have developed resistance to organophosphate products. Signal word: Caution, making this product desirable for use by the general public.

PennCap-M (encapsulated methyl parathion): This encapsulated formulation of methyl parathion with its extended residual activity is registered for use on apple trees to control apple maggot, codling moth, green fruitworm, leafrollers, plum curculio, oystershell scale, San Jose scale, tarnished plant bug, and woolly apple aphid. It is used on nectarine, peach, plum, and prune trees for control of lesser peachtree borer, peachtree borer, cat-facing insects, oriental fruit moth, plum curculio, and peach twig borer; and on cherry trees for black cherry aphid, cherry fruit fly, green fruitworm, leafrollers, and plum curculio. PennCap-M is a restricted-use product. PennCap-M is very hazardous to bees and must not be applied whenever flowering weeds occur in or around the orchard. Signal word: Warning.

Synthetic Pyrethroid Products

Use of pyrethroid insecticides is likely to cause mite outbreaks in apples. These materials are highly toxic to mite predators and have a long residual activity.

Ambush (permethrin): Ambush is registered as 2 lb/gal. EC and a 25% WP for apple trees to control apple aphid, leafrollers, plum curculio, white apple leafhopper, spotted tentiform leafminer, and tarnished plant bug. Do not use after petal fall for

apples. Use on cherry and peach trees to control lesser peachtree borer, rose chafer, green fruitworm, red-banded leafroller, plum curculio, and tarnished plant bug; and on pears to control pear psylla, codling moth, and green fruitworm. Ambush is a restricted-use product. Signal word: Warning.

Asana XL (esfenvalerate): Asana is registered as a 0.66 lb/gal. EC on apples to control leafrollers, codling moth, white apple leafhopper, tentiform leafminer, San Jose scale (on fruit only), aphids, plum curculio, apple maggot, green fruitworm, tarnished plant bug, stink bugs, and periodical cicada. It is used on stone fruits to control peach twig borer, oriental fruit moth, peachtree borer, lesser peachtree borer, periodical cicada, aphids, leafrollers, leafhoppers, and green fruitworm. It is used on pears to control pear psylla, codling moth, green fruitworm, plum curculio, leafrollers, pear slug, and periodical cicada. Asana is a restricted-use product. Signal word: Warning.

Pounce (permethrin): Pounce is registered as a 3.2 EC and 25% WP to control the same insects as Ambush. Pounce is a restricted-use product. Signal word: Warning.

Other Products

Agri-Mek (abamectin): AgriMek is registered as a 0.15 lb/gal. EC. It is used to control pear psylla on pears and European red mite and spotted tentiform leafminer on apples. Agri-Mek is very effective when timed properly. Agri-Mek is used post-bloom and is most effective when used within 6 weeks of petal fall. During this period after petal fall, Agri-Mek can still penetrate into the leaf. Used early (up to 6 weeks after petal fall), Agri-Mek will provide excellent control; when used later in the season, control is only fair. Agri-Mek is most effective when applied with a minimum 1 percent of oil. Agri-Mek has a different mode of action from that of Apollo and Savey and can be alternated in a yearly rotation with these miticides to prevent development of mite resistance. Signal word: Warning.

Apollo (clofentezine): Apollo is formulated as 42% SC and registered as an ovicidal miticide on apples, pears, and stone fruits. Target species include European red

and two-spotted spider mites. It works best when applied to eggs or young mobile stages. It is not effective against older nymphs and adults. Apollo is limited to one application per year, with best results achieved with application at petal fall on pears and stone fruits. It must be applied by tight cluster on apples. There are no direct effects on predatory mites or bees. Keep in mind that Apollo and Savey have very similar modes of action, and both should not be used in the same season because of resistant-management concerns. Signal word: Caution.

Insecticidal Soaps and Horticultural Oils: SunSpray Ultra-Fine, Saf-T-Side, and M-Pede (a potassium salt of fatty acids, previously called an insecticidal soap) are relatively new insecticides that may be used in certified organic production systems. Summer oils and M-Pede are effective against only the insects that are present and contacted by sprays at the time of application. These sprays provide no residual control. Nonetheless, they appear to be useful in certain situations.

A summer oil alone at a concentration of 1 to 2 percent by volume provides some control of mites and aphids (rosy apple aphid, apple grain aphid, green apple aphid, and spirea aphid). Limited observations suggest that aphid control is likely to be greatest if oil is applied when clusters are at the 1/4-inch green stage.

M-Pede alone reduces mite, aphid, pear psylla, and white apple leafhopper populations, but control may not be satisfactory or long-lasting unless multiple sprays are applied. Unlike oils, M-Pede is not ovicidal. If applied alone, a summer oil is likely to be more effective for aphid and (especially) mite control than M-Pede. Data from Michigan indicate that adding M-Pede at 2 percent by volume to full-rate sprays of Omite, Vendex, Kelthane, and presumably other miticides greatly enhances the control they provide.

Phytotoxicity, leaf drop, and fruit blemishes should be a major concern in decisions on the use of a summer oil or soap. To prevent damage to foliage or fruits, never use a summer oil with Captan, Sevin, or other sulfur-containing pesticides. Allow at least 14 days between applications of sulfur-containing compounds and the use of a summer oil. Do not

apply oils if temperatures exceed 90°F or if drying conditions are poor. Because of concerns about fruit russetting, some authorities suggest that insecticidal soaps should be used only in nonbearing orchards. Russetting problems appear to be linked to quality problems in soap formulations produced before 1992. To minimize any risk of fruit damage in bearing orchards, use only M-Pede, not older soap products. Oils and soaps must be mixed at the proper dilution (1 to 2 percent); concentrated sprays will be less effective and more phytotoxic. Deposits of large droplets or the coalescing of droplets on fruit or foliage also increases the likelihood of leaf damage and fruit blemishes.

Mitac (amitraz): This formamidine insecticide-miticicide is available as EC and 50 WP formulations for use on pears to control mites and pear psylla that are resistant to organophosphates and pyrethroids. Not effective in cold weather. Apply when temperatures exceed 60°F. Signal word: Warning.

Morestan (oxythioquinox): Morestan is formulated as a 25% WP in water-soluble packets and registered for control of mites and mite eggs on apple and pear (fruit-bearing) trees in pre-bloom sprays (delayed dormant, pre-pink, or pink). It is also effective against pear psylla nymphs and assists with early-season powdery mildew control. Do not apply after first bloom. Can also be applied post-harvest. It can be used on apricots as a post-harvest application for mites. This product can be applied to nonbearing cherry, nectarine, peach, plum, and prune trees, but not to trees that will bear fruit within 1 year of application. Signal word: Caution.

Provado (imidacloprid): Provado is a 1.6 lb/gal. flowable formulation and is registered for post-bloom control of leafhoppers, San Jose scale, leafminers, and aphids. Applications timed at petal fall will provide greatest leafminer control. Indications are that Provado does not affect beneficial insects severely in apples. These products show some systemic or translaminar activity. With foliar applications, good coverage of the foliage is needed for optimal control. Provado is highly toxic to honeybees, so sprays must be applied after petal fall and should not drift onto flowering weeds. Signal word: Caution.

Pyramite (pyridazinone): Pyramite is registered as a 60% WP in water-soluble packets for control of European red mites and two-spotted spider mites on apples and the same mites as well as pear psylla on pears. While all stages of mites are affected, Pyramite is most effective against immature motile stages. Pyramite provides long residual activity and is highly toxic to mite predators.

Savey (hexythiazox): Savey is formulated as 50% WP and registered as an ovicidal miticide on apples and pears. Target species include European red and two-spotted spider mites. It works best when applied to eggs or young mobile stages. It is not effective against older nymphs or adults. Savey is limited to one application per year, with best results achieved with application at petal fall on pears. It must be applied prior to bloom on apples. There are no direct effects on predatory mites or bees. Keep in mind that Apollo and Savey have very similar modes of action, and both should not be used in the same season because of resistant-management concerns. Signal word: Caution.

Superior Oil: Superior-type oils are highly refined to eliminate most possibilities of oil toxicity to leaf tissue and yet give a maximum insect and mite control. Best control is found to be for dilute spray applications. Thorough coverage is important for good control. Do not apply when temperatures are near freezing during the 24 hours before or after the application is to be made.

Vendex (hexakis, fenbutatin-oxide): Both formulations, 50% WP and 4 L, are reported to give long residual control of mites on apple, cherry, peach, pear, plum, and prune trees. Both formulations can readily be dispersed in water and can be used in conventional dilute or concentrate sprayers, even when honeybees and/or beneficial mites are present. Vendex is relatively nontoxic to bees and predator mites. This product is corrosive and may cause skin irritation, respiratory irritation, and eye damage. Do not apply through an irrigation system. Vendex is relatively slow-acting. Signal word: Danger.

Table 17. Effectiveness of selected insecticides and miticides against peach pests.

Material	Green peach aphid	Plum curculio	Tarnished plant bug	European red mite	Cherry fruit flies	Oriental fruit moth	Peachtree borer	Lesser peachtree borer
Ambush	G	G	E	-	E	E	G	G
Apollo	-	-	-	E	-	-	-	-
Asana XL	G	G	E	-	E	G	E	E
Carzol	-	-	G	E	-	-	-	-
Diazinon	G	G	G	-	G	E	E	E
Endosulfan	-	-	-	-	-	-	E	E
Guthion	P	E	G	-	E	E	G	G
Imidan	P	E	G	-	E	E	G	G
Kelthane	-	-	-	E	-	-	-	-
Lannate	E	G	G	-	G	E	F	F
Lorsban	-	-	-	-	-	-	E	E
Pennacp-M	P	E	E	-	E	E	G	G
Pounce	G	G	E	-	E	E	G	G
Sevin	P	F	F	-	G	G	F	F

Rating system; E = excellent, G = good, F = fair, P = poor, - = not rated.

Orchard Herbicides

2,4-D Amine: This systemic post-emergence broad-leaf herbicide is absorbed by foliage and translocated to other parts of the plant. Growth regulator type of action causes abnormal growth and death of susceptible plants. Used in apple and pear orchards to control orchard floor perennial broadleaf weeds such as dandelion, etc. Must be applied as a directed spray at low pressure to eliminate drift because the fruit trees are also susceptible to the herbicide. Do not allow spray to contact leaves, fruit limbs, or trunk as injury will result. It is best applied after harvest. 2,4-D is almost impossible to remove completely from sprayers. Do not use 2,4-D in a sprayer which will later be used for foliar application to fruit crops. Do not use 2,4-D if grapes are grown nearby.

Casoron, Norosac (dichlobenil): A pre-emergence herbicide controlling both seedling broadleaf and grassy species. Dichlobenil should be applied in the dormant season. Dichlobenil is usually available as a

Table 18. Insecticide and miticide efficacy guide for apple pests.

Material	Apple maggot	Plum curculio	Codling moth	Red-banded leafroller	Green fruitworm	Rosy apple aphid	Green apple aphid	Woolly apple aphid	San Jose scale	Tarnished plant bug	Spotted tentiform leafminer		White apple leafhopper	European red mite	Two spotted spider mite	Apple rust mite	Predator mites
											Adult	Larva					
AgriMek	-	-	-	-	-	-	-	-	-	-	-	E	G	E	E	G	MT
Ambush	E	G	E	E	E	F	F	-	-	E	E	P	G	-	-	E	HT
Apollo	-	-	-	-	-	-	-	-	-	-	-	-	-	E	E	P	ST
Asana	E	G	E	G	E	F	F	-	G	E	E	P	G	-	-	G	HT
Carzol	-	-	-	-	-	-	-	-	-	-	G	-	E	G	G	G	HT
Dimethoate	G	F	G	F	P	G	E	E	G	-	-	P	G	F	F	F	ST
Diazinon	G	F	G	G	F	F	G	G	G	P	-	F	F	-	-	-	ST
Guthion	E	E	E	G	F	P	P	F	F	P	P	-	P	-	-	-	ST
Imidan	E	G	E	G	F	P	F	F	F	P	P	-	F	-	-	-	ST
Kelthane	-	-	-	-	-	-	-	-	-	-	-	-	-	F	F	F	HT
Lannate	F	F	G	E	G	G	G	-	-	G	G	E	E	-	-	-	HT
Lorsban	G	F	G	E	G	G	G	E	E	P	P	F	P	-	-	-	MT
Morestan	-	-	-	-	-	-	-	-	-	-	-	-	-	G	G	G	-
Oil 70 Sec.	-	-	-	-	-	F	F	-	E	-	-	-	-	E	E	P	ST
Penncap-M	E	G	E	E	G	G	F	G	E	F	P	P	F	-	-	-	ST
Pounce	E	G	E	G	E	F	-	-	-	E	E	P	-	-	-	E	HT
Pyramite	-	-	-	-	-	-	-	-	-	-	-	-	G	E	E	-	HT
Provado	-	-	-	-	-	G	G	-	-	-	-	E	E	-	-	-	MT
Savey	-	-	-	-	-	-	-	-	-	-	-	-	-	E	E	-	ST
Sevin	G	G	G	F	F	F	G	P	F	-	-	-	G	-	-	-	HT
Thiodan	-	F	F	F	G	G	G	E	F	G	E	P	F	-	-	E	ST
Vendex	-	-	-	-	-	-	-	-	-	-	-	-	-	F	F	F	ST
Vydate	-	-	-	-	-	G	G	-	-	-	-	G	G	G	G	G	HT

Rating system: E = excellent, G = good, F = fair, P = poor, - = not rated for this insect or mite, HT = highly toxic, MT = moderately toxic, ST = slightly toxic.
 NOTE: Rating system is based on moderate insect pressure; heavy pressure may require higher dosages, shorter spray intervals, or both.

4 percent granular material. Care must be taken to apply uniformly, especially on young trees. A tractor-mounted granular spreader is desirable for uniform application. Dichlobenil can evaporate rapidly at higher temperatures, so shallow incorporation or rainfall after application would be helpful. Seed germination and growth of young seedlings are inhibited. The emerging sprouts of some perennial weeds are inhibited at higher dosages. When fall- or winter-applied at 6 lb of active ingredient (150 lb of 4 percent granules) per acre this product can be

expected to control weeds and grasses until late summer. Regrowth of weeds at this time may be desirable to slow down growth of trees in preparation for winter.

Devrinol (napropamide): Devrinol is a pre-emergence herbicide that can be used in newly planted or bearing orchards. It is most effective on annual grasses. It must be applied to weed-free soil or supplemented with a post-emergence herbicide. Devrinol is quickly decomposed by light and must be

incorporated by tillage, rainfall, or irrigation within 24 to 48 hours of application. Because of the need for incorporation, Devrinol has limited application for tree fruit plantings.

Fusilade (fluazifop-p-butyl): A post-emergence grass herbicide. Fusilade is not effective on broadleaf weeds. Should be used in about 25 gal. of water per acre with a crop oil concentrate or nonionic-surfactant (check product label). Should be used on actively growing grasses generally less than 6 to 8 inches tall. Cannot be expected to control annual bluegrass or grasses that have overwintered. Labeled only for nonbearing fruit trees that will not bear a crop within 1 year of application.

Goal (oxyfluorfen): At lower rates, Goal is a post-emergence herbicide for control of broadleaf weeds. At higher rates, it is a post-emergence and long-term pre-emergence material. It is registered for use in apple, pear, peach, plum, cherry, and prune orchards. Can be tank-mixed with certain other pre-emergence materials for broader spectrum control (see label). Can also be combined with paraquat or glyphosate for post-emergence weed control. Goal must be applied only between October 1 and February 15 to avoid potential plant injury.

Gramoxone Extra (paraquat): A post-emergence nonselective herbicide. Effective in killing most annual weeds and grasses when applied to actively growing weeds less than 4 to 6 inches in height. Helps to suppress some perennial weeds by killing top growth. Weed kill is very rapid under high temperatures. There is no residual action, and new seedlings or new growth may emerge from perennial weeds. Acts as a chemical hoe. Thorough coverage of foliage is necessary, and the addition of a wetting agent or spreader will enhance effectiveness. May be combined with pre-emergence herbicides for season-long weed control. Do not allow spray to contact foliage, fruit, or stems of plants as severe damage may result. Do not allow spray to contact immature, green bark of trunk as damage will result. Paraquat is very toxic to humans. Extreme care should be taken to prevent any contact with the concentrated material. Inhalation of spray mist can be hazardous. Never save paraquat in an unlabeled container or a food-type

container. Gramoxone Extra is a restricted-use material.

Karmex (diuron): A pre-emergence annual grass and broadleaf weed herbicide. Applied in spring at the recommended dosage to weed-free soil, Karmex can be expected to provide season-long control. Use only on established trees.

Kerb (pronamide): Kerb is a pre-emergence herbicide primarily for annual and perennial grasses and certain broadleaf weeds. It is not effective on some of the broadleaf weeds. Should be applied to weed-free ground in the cool season after harvest in the fall but before the leaves drop and the soil freezes. Under dry conditions, added moisture will improve effectiveness. Sensitive to soil type, with lower rates for light-colored sandy soils and higher rates for darker soils with more organic matter. Not effective on organic soils.

Poast (sethoxydim): Poast is a post-emergence grass herbicide that controls most annual and perennial grasses. It is not effective on broadleaf weeds. Cannot be expected to control small grain plants that have tillered or overwintered. Should be used with a crop oil concentrate or nonionic surfactant (check product label). Apply on actively growing grasses 4 to 6 inches tall. Do not apply under trees that will be harvested within 1 year of application.

Princep (simazine): Princep is a pre-emergence herbicide that is effective on germinating seeds and young seedling plants. It can be combined with a post-emergence material for broad-spectrum control. When applied in late fall or early winter after harvest, no post-emergence herbicide is necessary, and Princep will control annual weeds and grasses and, to a large extent, the perennial grasses. Princep is sensitive to soil type, with lower rates suggested for lighter soils with less organic matter and higher rates for darker soils with more organic matter content. Do not apply to newly planted trees.

Prowl (pendimethalin): Prowl is a pre-emergence herbicide registered for nonbearing fruit trees only. Apply to weed-free soil. It controls most annual grasses and certain broadleaf weeds. Controls germinating seed, but will not control established

weeds. Requires 1/2-inch of moisture from rainfall or irrigation within 7 days after application to incorporate.

Rely (Glufosinate-ammonium): A post-emergence nonselective contact herbicide that is slightly systemic. Cleared on bearing and nonbearing apples, but not on trees within 1 year of transplanting. Avoid contact with the fruit tree foliage or green bark. Controls a wide range of annual and perennial broadleaf weeds and grasses. Can be applied with a wick or as a broadcast or spot spray.

Roundup Ultra (glyphosate): A post-emergence nonselective herbicide, Roundup Ultra will control both annual or perennial weeds. It is foliar-applied and translocates downward to the root system. For this reason, it is best applied close to bloom or late in the season when weeds are growing actively and translocating carbohydrates downward. Application too early may result in regrowth of weeds. Effective in control of such perennial weeds as Canada thistle, field bindweed, etc. It is inactivated rapidly on contact with soil. Do not allow contact with any part of the fruit plant, especially when applied late in the season as severe damage may result. Frequently symptoms of glyphosate damage do not appear until growth begins in the spring following application. Contact with suckers or low limbs after about July 1 can result in selected branches having very small leaves the following season. Early-season contact to suckers around base of tree does not usually cause damage.

Sinbar (terbacil): Sinbar is a pre-emergence herbicide that is effective on germinating seeds and on young seedling plants. It is a very stable material that has long residual life, so buildup in the soil can occur. Because of the long residual period, do not use on orchards that will be removed and planted again

within 2 years. Sinbar moves readily in sandy soils and can result in damage to fruit plants. Do not use on soils having less than 1 percent organic matter. Trees must be established at least 3 years.

Solicam (norflurazon): This pre-emergence broad-spectrum herbicide is registered for most fruit crops. See the current spray guide for crops and rates. Solicam is not effective on emerged weeds, so it must be applied to weed-free soil or combined with a post-emergence herbicide. Solicam is more effective on grasses than broadleaf weeds, and combinations with other herbicides will improve overall results. Solicam needs 1/2-inch of rainfall to be activated. Do not use on very coarse soils as root damage may result.

Surflan (oryzalin): This pre-emergence broad-spectrum herbicide will control most annual grasses and some broadleaf weeds. It is labeled for most fruit crops. See the current spray schedule for crops and rates. Must be applied on weed-free soil or combined with a post-emergence herbicide. Check labels for suggested tank-mixes. Surflan needs 1/2-inch of rain to move it into the soil and to activate it. Can be used safely on both established and newly planted trees after the soil has settled around the trees.

Touchdown (Sulfosate): A systemic nonselective post-emergence herbicide. Effective when foliarly applied in controlling a wide range of broadleaf, annual, and perennial grasses and some woody perennials. Requires a nonionic surfactant and may be applied as a broadcast, band, spot, or wick application. Can be tank-mixed with labeled pre-emergence herbicides for residual control. Cleared on nonbearing trees up to 1 year prior to harvest. Avoid contact with the fruit trees or serious injury can occur.