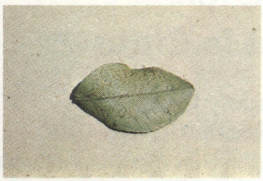
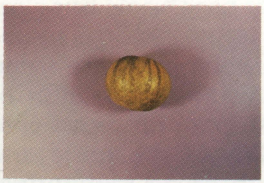
B-1336

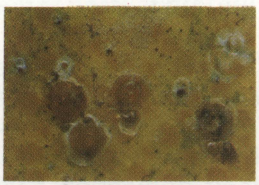


Melanose on Grapefruit

Brown Soft Scale

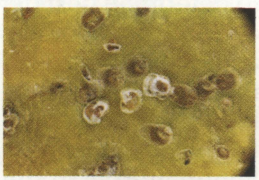


Citrus Melanose



California Red Scale

TEXAS GUIDE



Chaff Scale

FOR CONTROLLING PESTS AND DISEASES ON CITRUS

Glover Scales and
Purple Scales (top)

Citrus Rust Mite

Russeted Grapefruit

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Texas Guide for Pest Management in Citrus

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Insect, mite, disease and weed pests are some of the limiting biotic factors in the production of Texas citrus. The first step in optimum grove care involves accurate identification of the pests and their population levels through grove monitoring. Careful examination of groves at bi-weekly intervals to determine pest densities allows the citrus producer to evaluate the pest situation, select the most appropriate pesticides and make applications at rates which are most economical and least disrupting to the beneficial organisms in the grove. Since natural populations of beneficial species play an important role in the control of certain citrus pests, any pest management program must take their populations into consideration. The information contained in this guide should help the producer make effective and economical pest management decisions on pesticide selection, application rates and spray coverage. The effectiveness of pesticides on both pests and beneficials is presented.

INSECTS AND MITES

Mites

The *citrus rust mite* is the most serious pest of Texas citrus. It causes russeting of the fruit which lowers external quality. This mite must be controlled if a fresh fruit market is to be maintained. Rust mite populations increase during periods of high humidity (75 to 95 percent) and mild temperatures. Heaviest infestations usually are found on the northeast sides of the trees.

Texas citrus mites are principally leaf infesting and heavy populations can cause mesophyll collapse of the leaves. They prefer to feed in the top center of trees, on the upper surface of leaves during periods of warm, dry weather. These mites will move on to fruit but damage is not a problem when fruit matures. Leaves attacked will appear silvery gray and drop during the periods of strong, dry, north winds.

False spider mites are more prevalent through the summer months. Populations increase in the late spring on the leaves and young fruit toward the

inside of the tree and are later found on the outside leaves and fruit. Feeding on the fruit may cause spotting.

Scale Insects

Both armored and soft scales may cause economic damage in citrus. *Chaff scale* and *California red scale* are the key armored scales which may require pesticidal control in Texas citrus. *Purple scale* and *Florida red scale* are minor pests at present because of biological control by introduced parasites.

The soft scales such as *brown soft scale, cottony cushion scale* and *barnacle scale* are minor pests. Brown soft scale may become a major problem in areas where parathion use or drift occurs.

Scale insects usually increase during the spring and summer months. Miticides which have long-term detrimental effects on scale parasites could induce economic scale outbreaks.

Aphids

Aphids occasionally cause new foliage to curl downward on orange, tangerine and tangelo trees. They excrete "honeydew" on which the black sooty mold fungus grows. Infestations are more likely to occur on young trees. Control of aphids alone is seldom justified.

Citrus Mealybug

The *citrus mealybug* may become heavy in groves where certain organophosphate pesticides are used repeatedly for mite and/or scale control. They prefer grapefruit over orange trees. They are usually detected early in the season under the calyx of fruit, which is often not covered by pesticide application. Mealybugs excrete large amounts of honeydew in which black sooty mold grows, producing a crust protecting them from pesticides. The young stages of mealybugs are more easily controlled than the older, protected stages. Three primary parasites, the brown lacewing and lady beetles, provide natural control in groves where the use of certain organophosphate pesticides has been eliminated or greatly reduced.

Whitefly

The *citrus whitefly* and *cloudy-winged whitefly* are the most important of the five species on citrus. Whiteflies feed almost exclusively on the under surface of leaves. Adults tend to cluster on new growth. Whiteflies also excrete honeydew on which black sooty mold grows. Infestations tend to increase in

late spring and early summer. Tangerines and tangelos are preferred hosts, but grapefruit and oranges also are attacked. Whiteflies have been seen to increase following sulfur and certain organophosphate applications.

Ants

Ants may interfere with parasites and predators which feed or develop on certain pests. They may also spread insects that excrete honeydew on which black sooty mold grows. Native fire ants have been associated with bark injury. Texas leaf-cutting ants may defoliate citrus trees. They may be controlled with methyl bromide if their colonies are not near trees. Methyl bromide will kill or damage trees if applied directly to the root zone.

CHEMICAL CONTROL FOR INSECTS AND MITES

Dusts

Dusts should be applied when the air is calm and the temperature is 75 to 90 degrees F. A range of 50 to 80 pounds of dust per acre should be applied to mature trees to get sufficient coverage. Apply dusts to both sides of trees. Control will depend on completeness of coverage and type of active ingredient used.

Sprays

Spraying is more effective than dusting and is the only practical control method for scale insects. Spray applications should be based on economic pest population levels in the grove, not on a routine schedule. Thorough coverage of all tree parts is necessary to obtain maximum scale control. Air blast sprayers should deliver a minimum volume per acre in the range of 250 to 500 gallons of proper strength spray mix. A sprayer speed of not more than 1 mph will give the best coverage. More than 500 gallons per acre may be required to obtain optimum scale control. If concentrate sprays are applied, be sure that the labeled recommended rates of pesticides are applied per acre. Spreader stickers may be added to spray mixes to increase coverage and prolong effectiveness. Since some insecticides in solution may undergo chemical change creating potential hazards to the applicator or grove, mix only the amount of pesticide to be applied before the machine is stopped.

Oil

Oils can provide excellent control of armored

scales and Texas citrus mites if they are applied with thorough coverage. Oils do not eliminate many beneficials as do certain organophosphate pesticides. Improper use of oils may cause excessive leaf drop, twig dieback and reduction of fruit sugars. DO NOT USE OIL: 1) ON DROUGHT STRICKEN TREES; 2) WHEN RELATIVE HUMIDITY IS BELOW 30 PERCENT; 3) IN COMBINATION WITH SULFUR OR WITHIN 30 DAYS OF A SULFUR APPLICATION; 4) AT RATES EXCEEDING LABEL SPECIFICATIONS.

Tangerines and tangelos are more susceptible to oil damage than oranges and grapefruit. Reduced oil rates should be used on these citrus. Oil sprays, applied to grapefruit during the fall, may delay maturity, interfere with coloring of early harvested fruit and increase cold susceptibility.

The proper mixing of oils in the spray tank is an important procedure. Oils should be added to the tank with the engine running as the water level reaches the agitator shaft in the spray tank. Other spray chemicals should be added when the tank reaches two-thirds to three-fourths full. While spraying, continuous agitation is necessary to prevent oils from separating from the water phase of the spray mix.

Table 1. Gallons of oil concentrate to add per 500 gallons of spray mixture

Percent oil in concentrate	Gallons of oil concentrate to make	
	1% Mixture	1.6% Mixture
97-99	5	8
80-84	6	10

Table 2. Recommended specifications for citrus spray oils

	Narrow-range[1] 440 Type	Narrow-range[1] 415 Type
50% Distillation Temperature 10 mm Hg °F, A.S.T.M. Method D-1160	432-448	412-418
Temperature spread for 10-90% distilled	Max. 80°	Max. 60°
Percent carbon atoms in paraffinic structure (RI-KVGC Analysis)	Min. 60%	Min. 60%
Percent unsulfonated residue (A.S.T.M. Method D-483)	Min. 92%	Min. 92%
Pour Point (Degrees F) (A.S.T.M. Method D-97)	Max. + 20° F	Max. + 20° F

[1]The 440-type oil will provide superior scale control and is preferred for this use. Coverage is extremely important with both types.

Aerial Application

Sprays and dusts applied with ground equipment provide more effective coverage than those applied by air. It may become necessary to use aerial application for low population mite control when groves have recently received rain and/or irrigation. Applications by air, under high mite densities, are usually only marginally effective. Proper timing and multiple applications by air are usually required to achieve economic control.

DISEASES AND NEMATODES

Melanose

Melanose is a fungal disease which is more prevalent in older groves and in trees with deadwood, particularly in areas of the Valley where humidity is high. Symptoms of melanose are found on leaves, twigs and fruit. Only grapefruit is seriously affected, infection occurring when fruit is young. No reduction in yield has been observed. The economic damage is caused by lowered external quality of blemished fruit. Adding a copper spray to the post-bloom application has been the common practice for melanose control. When conditions are conducive to melanose development, such as frequent spring rains, additional fungicide applications may be necessary to provide protection until fruit reach about three inches in diameter.

Greasy Spot

Humid conditions favor greasy spot development. Trees that are severely infected with this fungal disease may drop leaves prematurely. The disease is often associated with citrus rust mite injury. Fungicide applications for melanose will reduce greasy spot, as well as inclusion of oil in the summer spray.

Sooty Mold

Sooty mold is a black fungus that grows on the honeydew excreted from several insects that attack citrus. These include aphids, brown soft scale, mealybugs, whiteflies, citrus blackfly and cottony cushion scale. The appearance of honeydew and sooty mold indicates an infestation of one or more of these insects. Oil sprays applied during the summer will control some of the insects that produce honeydew, thereby reducing or eliminating the growth of sooty mold.

Nematodes

The citrus nematode is a serious pest affecting Texas citrus groves. The decision to treat a grove for control of the citrus nematode should be based on three factors: 1) soil and root analysis should indicate high population of the nematode; 2) previous history of the grove should have established that adequate watering, fertilization and other cultural practices have failed to produce proper yields; and 3) the yield potential should be great enough to justify the extra cost of treatment. Another consideration in deciding to treat for nematodes and the rates of product to use is the fact that the only product presently available (Summer, 1980) also is effective in the control of certain insects and mites, therefore making it necessary to consider the benefits of multiple pest control.

Post-Harvest Diseases

Post-harvest diseases can cause serious damage to Texas citrus, reducing yield, quality and profit. Growers often overlook the importance of these diseases, thinking that it is only a problem in the packing house, while in reality much can be done in the grove to avoid later disease development. Throughout the year, recommended pest control and cultural practices should be followed to insure good quality fruit. At harvest, injuries should be avoided while picking, handling, loading and packing fruit. Wounds serve ideally for entrance of disease-causing organisms. Care should be taken not to bruise fruit with fingernails, ladders or boxes. Twigs, leaves and branches should not accumulate in boxes; boxes should be kept off the ground. Packing houses should be kept clean and sterile; disinfectants and fungicides listed in the table of recommendations should be used to spray equipment, fruit and boxes. Fruit should be kept refrigerated during transportation to reduce incidence of disease.

WEED CONTROL

Chemical weed control may be either trunk-to-trunk control of the entire grove floor or control only in the tree rows with a sod middle. Herbicide rates should be computed per treated acre in either case.

Herbicides should be applied in March-April and August-September, with any necessary spot treatment as needed during July. The rate per treated acre should be applied in 50 to 100 gallons of water or as specified on the product label. See Table 6.

TABLE 3. Pesticides and rates of formulation per acre for *insect* and *mite* pests of Texas citrus.

CITRUS PESTS	[1] aldicarb (Temik® 15G)	[2] azinphosmethyl (Guthion® 2S or 2L)	[3] carbaryl (Sevin® 80% WP)	[4] carbophenothion (Trithion® 8E)	[5] chlorobenzilate (Acaraben® 4E)	[6] dialifor (Torak® 4EC)	[7] dimethoate (Cygon® 400 Rebelate® DeFend®)	[8] dioxathion (Delnav® 8ES)	[9] ethion (Ethion® 4EC)	[10] fenbutaxtin-oxide (Vendex® 50 WP)	[11] formetanate hydrochloride (Carzol® SP, 92%)	[12] dicofol (Kelthane® EC 18.5%)	[13] methidathion (Supracide® 2E)	oil (440)	propargite (Comite® 6.7 lbs/gal)	sulfur (Liquid 52%, 6 lbs/gal)	zineb (Zineb® 75 WP)
Citrus rust mite	33 to 67 lb	NS	NL	3¾ pt	3 to 5 pt	NS	NL	2 to 4 pt	2 to 4 pt	1 to 2 lb	7 to 20 oz	5 to 6 qt	NL	NL	2 pt	5 pt	2 to 5 lb
Texas citrus mite	NL	1 gal	NL	3¾ pt	NS	NS	4 to 5 pt	2 to 4 pt	4 to 8 pt	1 to 2 lb	NL	5 to 6 qt	NL	8 gal	NS	NS	NL
False spider mites	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	5 to 6 qt	NL	NS	NS	NL	NL
Chaff scale	NL	1 gal	NL	NL	NL	NL	NS	NL	NS	NL	NL	NL	5 to 8 pt	8 gal	NL	NL	NL
California red scale	NL	1 gal	NS	NS	NL	NL	NS	NL	NS	NL	NL	NL	5 to 8 pt	8 gal	NL	NL	NL
Purple scale	NL	1 gal	NL	NS	NL	NL	NS	NL	NS	NL	NL	NL	NL	8 gal	NL	NL	NL
Florida red scale	NL	NS	NL	NS	NL	NL	NS	NL	NS	NL	NL	NL	NL	8 gal	NL	NL	NL
Brown soft scale	NL	1 gal	1½ to 3 lb	NS	NL	6 to 8 pt	NS	NL	NS	NL	NL	NL	5 to 8 pt	NS	NL	NL	NL
Citrus mealybug	NL	1 gal	NL	NL	NL	NL	4 to 8 pt	NL	NS	NL	NL	NL	NL	NS	NL	NL	NL

NL = Not labeled for use on this pest NS = Not suggested by Texas Agricultural Extension Service, Research, and CITRUS INSECTS, ARS, USDA, Weslaco, Texas.
lb = pounds pt = pints oz = ounces qt = quarts gal = gallons

[1]Labeled only on oranges

[2]Do not apply with oil unless specified on label. Allow seven days between last application and harvest; 28 days where two applications are made. Apply no more than two applications per year. Do not enter grove within seven days of application.

[3]Not labeled for use on kumquat or citron. Do not apply to grapefruit after July 1, or within 30 days of previous application, where more than one application is required. Do not apply within 14 days before harvest.

[4]Do not make a second application within three months if fruit were present on the tree at the time of first application. Do not apply within seven days of harvest.

[5]Do not repeat application within three months of previous treatment. Do not repeat within four months or apply more than twice a year on lemons or limes.

[6]Do not repeat application within 90 days of previous treatment. Do not apply more than once per season on lemons or twice per season on tangerines.

[7]Apply only with ground equipment. Do not apply more than four applications per year. Do not apply on tangerines and tangelos.

[8]Labeled for use only on grapefruit, kumquats, lemons, limes, oranges, tangelos and tangerines.

[9]Allow 45 days between applications. Do not apply more than two applications per growing season. Do not graze treated areas. May reduce residual control of citrus rust mite, Florida red scale and Texas citrus mite.

[10]Do not use oil if humidity is below 30 percent. Do not apply to drought stricken trees. Do not use in combination with sulfur or within 30 days of sulfur application.

[11]Do not use with oil.

[12]Do not use with oil or within four weeks of oil spray.

[13]Unsatisfactory citrus rust mite control under heavy infestations.

TABLE 4. Effects of various pesticides against certain Texas citrus pests, parasites and predators

CITRUS PESTS:	azinphosmethyl (Guthion® 2S or 2L)	carbaryl (Sevin® 80% WP)	carbophenothion (Trithion® 8E)	chlorobenzilate (Acaraben® 4E)	copper	dimethoate (Cygon® 400 Rebelate® Defend®)	ethion (Ethion® 4EC)	fenbutaxtin-oxide (Vendex® 50% WP)	formetanate hydrochloride (Carzol® SP 92%)	dicofol (Kelthane® EC 18.5%)	methidathion (Supracide® 2E)	oil (440)	parathion	sulfur	zineb (Zineb® 75% WP)
Citrus rust mite	1	-	3-4	4	A	0	4	4	3	4	A	1	0	2-3	4
Texas citrus mite	2-3	D	3-4	1-2	A	3	3-4	4	3-4	4	D	3-4	1-2	1-2	0
False spider mites	D	-	C	4	-	-	C	-	-	4	-	3	-	3	0
Chaff scale	4	D	B	N	A	-	A	N	C	N	4	4	3-4	B-C	N
California red scale	3-4	D	A	N	A	-	N	N	C	N	3-4	3-4	3-4	B-C	N
Purple scale	3-4	D	A	N	A	-	N	N	-	N	4	4	3-4	C	N
Florida red scale	-	D	-	N	A	-	-	N	C	N	2	4	3-4	C	N
Brown soft scale	4	4	3	N	-	-	1-2	-	A	N	4	3	D	-	-
Citrus mealybug	2-3	1	-	N	-	2-3	-	-	-	N	-	1-2	-	-	N
PARASITES:															
Ext. chaff scale	c-d	d	c	N	a	a-b	b	N	c-d	N	c-d	a	d	b-d	N
Int. chaff scale	c-d	b	c	N	a	a-b	b	N	c-d	N	c-d	a	d	b-d	N
Ext. CA red scale	d	d	c	N	a	-	c	N	d	N	b-c	a	d	b-c	N
Ext. purple scale	d	d	c	N	a	-	c	N	-	N	-	a	d	b-c	N
Ext. FL red scale	d	d	c-d	N	a	-	c	-	c-d	N	c-d	a	d	c-d	-
Int. brown soft scale	d	d	-	-	-	d	-	-	-	-	-	a	d	d	-
Int. citrus mealybug	d	d	b-c	N	-	c-d	b-c	-	-	N	b-c	a	-	-	-

Table 4: (cont'd.)

PREDATORS:	azinphosmethyl (Guthion® 2S or 2L)	carbaryl (Sevin® 80% WP)	carbophenothion (Trithion® 8E)	chlorobenzilate (Acaraben® 4E)	copper	dimethoate (Cygon® 400 Rebelate® Defend®)	ethion (Ethion® 4EC)	fenbutaxtin-oxide (Vendex® 50% WP)	formetanate hydrochloride (Carzol® SP 92%)	dicofol (Kelthane® EC 18.5%)	methidathion (Supracide® 2E)	oil (440)	parathion	sulfur	zineb (Zineb® 75% WP)
Lady beetles	c-d	d	a-b	N	-	a	a	-	-	N	a-b	a	-	-	-
Brown lacewing	d	d	b-c	N	-	c-d	a	-	-	N	c	a-b	-	-	-

Degree of kill on target pest ("0" lowest to "4" highest); Degree increase as non-target pest ("A" lowest to "D" highest); Degree effect on parasites and predators ("a" lowest to "d" highest). N = no effect noted. (-) = no information. (Ext.) and (Int.) = external and internal parasites.

SOURCE: Texas Agricultural Experiment Station and Citrus Insects, ARS, USDA, Weslaco, TX, 1980.

TABLE 5. Fungicides and nematicide and rates of application per acre for disease and nematode control in Texas citrus.

	copper hydroxide (Kocide 101®)[1]	(Tribasic Copper®)[2]	copper ammonium carbonate (Copper-Count-N®)[3]	Oil	thiabendazole (Mertect 260®)[4]	thiabendazole (Fungicide conc. 1020 and 6®)[4]	benomyl (Benlate®)[4]	thiabendazole (Fungicide conc. 2020®)[4]	benomyl (Freshgard 113®)[4]	(Sopp®)[6]	Biphenyl[5]	aldicarb (Temik 15G®)[7]
Melanose	5 lb	15 lb	4 gal									
Greasy Spot	5 lb	15 lb	3 gal	8 gal								
Post-Harvest Disease					1.5 to 7.0 lb/ 100 gal	1000 to 3000 ppm	1 to 2 lb/ 100 gal	1000 to 3000 ppm	600 to 2400 ppm	2000 to 3500 ppm	see note	
Nematodes												66 lb

[1]Two or more applications provide best control. For single post-bloom application use 7.5 lb per acre. Kocide 606, a liquid formulation may be substituted at equivalent rates.
[2]Finely ground liquid formulation such as Super-Cu is labeled for use at 1 to 1.5 gallons per acre. Two or more applications are suggested.
[3]Do not apply with oil.
[4]Apply as a dip or spray, incorporate into the citrus wax. Do not immerse fruit in Benlate for more than five minutes.
[5]Several formulations are available. Do not treat fruit for more than five minutes; rinse thoroughly after application.
[6]Must be impregnated in pads; already-impregnated pads are available.
[7]Labeled for oranges only.
lb = pounds, gal = gallons, ppm = parts per million

TABLE 6. Herbicide application rates per treated acre for Texas citrus[1]

Herbicide	Weed Type			
	Broadleaf Weeds	Annual grasses	Perennial grasses	Established weeds
EPTC (Eptam[R] 7E)	3.5 pt	3.5 pt		
diuron[3 4] (Karmex[R] 80WP)	2 to 4 lb	2 to 4 lb		
simazine[3 4] (Princep[R] 80W)	2 to 6 lb	2 to 6 lb		
trifluralin[3] (Treflan[R] 4 lb/gal)	1 to 2 qt	1 to 2 qt		
paraquat[2] (Paraquat CL[R] 2 lb/gal)	1 to 2 pt	1 to 2 pt	1 to 2 pt	1 to 2 pt
Herbicidal weed oils[2]	20 to 50 gal	20 to 50 gal	20 to 50 gal	20 to 50 gal
dalapon[2 7] (Dowpon M[R] 74%)		1 lb/ 20 gal	1 lb/ 20 gal	
bromacil[3 7] (Hyvar X[R] 80W)	8 lb/yr max	8 lb/yr max	8 lb/yr max	8 lb/yr max
terbacil[2 3 5] (Sinbar[R] 80W)	10 lb/yr max	10 lb/yr max	10 lb/yr max	10 lb/yr max
cacodylic acid[2 8] (Phytar 560[R] 2.48 lb/gal)	1.5 to 2 gal	1.5 to 2 gal	1.5 to 2 gal	1.5 to 2 gal
monosodium methanearsonate[2] (MSMA 6 lb/gal, Bueno-6[R])	2.66 to 5.33 pt	2.66 to 5.33 pt	2.66 to 5.33 pt	2.66 to 5.33 pt
bromacil + diuron, 2:2[3 6] (Krovar I[R] 80% W)	2 to 6 lb	2 to 6 lb	2 to 6 lb	2 to 6 lb
bromacil + diuron, 2:1[3 7] (Krovar II[R] 80W)	4 to 8 lb	4 to 8 lb	4 to 8 lb	4 to 8 lb
ametryn[2 5] (Evik[R] 80W)	2 to 8 lb	2 to 8 lb	2 to 8 lb	2 to 8 lb
glyphosate[2] (Roundup[R] 4 lb/gal)	1 to 1.5 qt	1 to 1.5 qt	1 to 1.5 qt	1 to 1.5 qt

[1]Pounds of product per treated acre = pounds of active ingredient per acre X 100 ÷ percent active ingredient.

[2]Postemergent control of green, growing plants.

[3]Preemergent and postemergent seedling control.

[4]Use only on groves established at least one year, lower rates for some herbicides based on the label.

[5]Use only on groves established at least two years.

[6]Use only on groves established at least three years.

[7]Use only on groves established at least four years.

[8]Use only on non-bearing groves.

lb = pounds, pt = pints, qt = quarts, gal = gallons

The information given herein is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the Texas Agricultural Extension Service is implied.

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