Crop Profile for Melons in California

Prepared: October, 1999

General Production Information

(Cantaloupes and Honeydews)

- California ranks 1st in the nation in cantaloupe and honeydew melon production (13).
- In the U.S. in 1998, approximately 59% of the cantaloupes and 76% of honeydew melons were grown in California (13).
- Cantaloupes were grown and harvested on approximately 63,000 acres in California in 1998, with a total cash value of $249,480,000 and an average of $3,960 per acre (13).
- Honeydew melons were grown and harvested on approximately 20,500 acres in California in 1998, with a cash value of $75,174,000 and an average of $3,667 per acre (13). Table 1 (found in the appendix) lists the 1998 melon acreage which shows a reduction in harvested acreage reported by the various county agricultural commissioner's office. County specific production data has been collected and provided courtesy of the California Melon Research Advisory Board (4).
- Total available 1998 production data shows an average cantaloupe yield per acre of 588 cartons of 40 pounds each and an average honeydew yield per acre of 780 cartons of 29 pounds each (4).
- Honeydews destined for Japanese markets must be blemish free and as a result, higher pesticide use patterns may be seen for honeydews as evidenced by the specific use data in many of the following pages.

Production Regions

The main melon-growing areas in California are shown in Figure 1 on page 6. Area I consists of Merced, San Joaquin, and Stanislaus Counties in the northern part of the San Joaquin Valley. Minor planted acreage can also be found in Yolo and Colusa Counties in the Sacramento Valley, as that region remains primarily more of a melon seed production area. Based on 1998 production data collected by county agricultural commissioners' offices, Area I grows about 18% of the state's cantaloupes and about 19.5% of the honeydew melons. Planting of melons extends from April to early July and harvest from late June to mid-October (5).

Area II, the San Joaquin Valley south of Merced County produces 49% of the cantaloupe melons, planting from mid-March to early July and harvesting from late June to mid-October. This area also produces about 48.5% of the honeydew melons. Planting and harvest of honeydew melons closely...
follows that of cantaloupe melons. The main melon production in this area lies on the westside of the San Joaquin Valley in Fresno, Kings, and Kern Counties (5).

Area III covers the Imperial, Coachella, and Palo Verde Valleys. This region produces about 33% of the state's cantaloupe melons and approximately 32% of the honeydews. The region has both a spring and a fall crop. The spring planting period is from February to April with a harvest from June to early July. The fall planting period is from late July to early-August with a harvest window from mid-October to late November (9,12).

Figure 1. Major melon-producing areas in California.

Cultural Practices

California melons are grown for sales periods when consumer demand, and therefore price, is high. This is especially true for the southern deserts (Area III). Both cantaloupe and honeydew melon growers recognize the importance of this timing and plan their plantings accordingly, oftentimes watching other state's melon acreage, such as Texas and Arizona. Melons from a single planting are generally delivered to market within a two-week harvest period, with several picks for honeydews and as many as 12 to 15 picks for cantaloupes. Melons are considered a highly perishable crop and market supply and demand greatly influences prices at harvest time. Growers carefully plan their acreage and planting dates in order to avoid severe market price fluctuations.

Land preparation is the first step before planting melons. Almost all melons are planted on raised beds in California. This facilitates cultivation and irrigation of the melon crop, as well as improving drainage, which minimizes root diseases. Land preparation consists of proper grading (particularly if furrow irrigation is used), subsoiling to break up compacted layers, listing, and final bed preparation. Melon beds are most often 80 inches wide, though some honeydew production in the northern regions is grown on 60-inch beds. Listing is often a critical step, as straight rows allow precision planting and close cultivation. Land preparation is often done in the fall if a spring planting is planned, as winter rains may prevent the use of heavy equipment needed for land preparation. Fallow bed herbicide treatments are sometimes used on pre-formed beds to prevent winter weed growth, and allow early spring melon planting.

Planting Method may differ depending upon the individual grower but about 98% of the cantaloupes
and 95% of the honeydews are direct seeded with the balance being transplants. Melons are direct seeded in one row per bed. Growers frequently use a high seeding rate when planting open pollinated varieties to ensure a good stand, with a labor crew sent in to thin the stand after melon emergence (around the first to second true leaf stage). Melons are precision planted with low seeding rates when hybrid seed is used. Hybrid varieties dominate the plantings in the desert-growing region. Open-pollinated varieties are still used in the main season in the San Joaquin and Sacramento Valleys but hybrid varieties are preferred during the later part of the growing season when plant disease and insect pressure increases.

In the southern deserts, special planting and growing methods are used to produce an earlier harvest and hit high value market windows in late spring. The traditional method is the "Yuma bed," a peaked bed running east to west in the field (9). The bed is 80 inches wide and about 30 inches tall. The melons are direct seeded in January to early March on the south-facing slope that is angled to get as much direct sunlight (and warmth) as possible. After the crop germinates, the beds are reshaped to create typical 80-inch beds. A newer method is the mid-bed trench, in which a V-shaped groove is made, again east to west in the field, about 12 inches wide and deep. The seed is sown on the south facing side of the groove and then the trench is covered at the top with a clear plastic mulch to create a mini-greenhouse. After the crop germinates, the plastic is first opened then removed, and the beds reshaped to the more normal 80-inch bed configuration. Both of these methods create special problems for pest control, especially weeds. On a smaller scale, some melons are being planted into clear or black polyethylene mulch and irrigated with buried drip tape, again for an earlier harvest.

Transplanting Transplanting provides the melon plants a head start on weeds and reduces stand establishment problems. However, transplants have a weaker taproot and more secondary roots than do direct seeded melons. Transplants are usually used in early spring to get a competitive edge against direct seeded crops and to get into the market place first.

Irrigation is used for all California melons. Furrow irrigation is the most commonly used irrigation method in California melons. Proper grading is critical for good drainage and for reducing disease levels. Furrows must be maintained throughout the season to avoid flooding the tops of beds, which will flood the bed tops increase weed emergence and the risk of fruit diseases.

Sprinkler Sprinkler irrigation is often used to germinate a direct seeded crop, except in the southern deserts. Sprinklers can also be used as a first irrigation after seedling emergence but should be used before pollination begins. Sprinkler irrigation is also beneficial for incorporation of some herbicides, such as trifluralin. Sprinklers are rarely used after fruit set, as the use of sprinklers has a tendency to drop flowers and increase fruit diseases, such as molds.

Drip Melon growers in California are increasingly using drip irrigation. Drip irrigation provides for good water management and allows hand harvesting at regular intervals. Subsurface drip irrigation is used on a small portion of drip-irrigated cantaloupes and honeydews and is the preferred method unless salty soils are encountered. By maintaining a dry surface during the summer growing season, weed
emergence is reduced along with water use.

**Honey bee pollination** is required for all melons because the sticky and large pollen grains are not moved by wind (8). Beekeepers provide this vital service to the melon industry by bringing in an average of one beehive for every planted melon acre for a period of approximately 30 days from open bloom. Recent outbreaks of several key pests have had an impact on beekeeping activities. Two species of mites (varroa and tracheal), fire ants, and Africanized honey bees have forced major changes in handling and moving of bee colonies. These pest threats to the beekeeping industry are very serious in nature and require extremely careful management.

**Harvest** of cantaloupes and honeydew melons can consist of picking and packing directly in the field or picking in the field followed by transport to a packing shed where the product is sorted and packed. The vast majority of cantaloupes harvested in California are field packed with subsequent forced air cooling after transportation to a cooling facility. Only about 40 percent of honeydews are field packed. Cantaloupes and honeydews destined for shed packing operations typically go through hydro-cooling with a chlorine dip involved for post harvest disease control.

**Insecticides** are used on about 90% of all melons grown in California. Insecticide treatments are used to control seed and seedling pests in early spring. Most treatments are applied to the melon foliage after crop emergence. Cantaloupes receive an average of three insecticide treatments, while honeydew melons receive an average of about four insecticide applications per year. The primary pests targeted by these treatments include darkling ground beetles, leafminers, spider mites, aphids, cabbage loopers, whiteflies, and leafhoppers. Honeydews destined for Japanese markets must be blemish free and as a result, higher pesticide use patterns may be seen for honeydews (1).

**Herbicides** are used for weed control on the majority, probably in the range of 60%, of the melons grown in California. The exact acreage is impossible to determine from the reported figures because more than one herbicide is often used on a single field. Occasionally, a preplant herbicide application is made on a six- to 10-inch band centered on the seedline. The area outside this seedline is **cultivated** to control weeds up to the time of **layby**. Layby is defined as the last time when cultivation equipment is used before harvest; melon vines are typically 5 to 10 inches long at layby. At layby, a preemergence herbicide is often applied to the area outside the seedline to control late emerging weeds (5).

**Fungicides** are used post emergent on approximately 80% of the melons grown in California. Cantaloupes generally receive 1.5 to 2 fungicide treatments per year, with the majority applied as foliar treatments. Fungicides are applied 1 to 1.5 times in honeydews, with most applications being foliar (1). The major disease organisms targeted by these treatments include the damping off complex of *Pythium* and *Rhizoctonia*, which is a problem in early spring melon growth, and powdery mildew, which becomes a problem after the development of full canopy (11). Most cantaloupe and honeydew seeds are pre-treated with fungicides such as Captan and Thiram by seed companies prior to delivery and subsequent planting.
Insect Pests

Numerous insect and mite pests attack melons in all of the growing regions of the state and can occur at damaging levels most seasons. Constant field monitoring is essential to signal flare-ups of various pests from planting to harvest. The pests can be divided into fruit and foliage pests such as lepidopterous larvae, other foliage pests such as aphids and leafminers, and seed and seedling pests such as wireworms and cutworms. The distribution and damage potential depends on production region and type of melon crop as honeydews grown for export have different pest tolerance levels compared to cantaloupes grown for the domestic market.

This report will review the major species that growers, packers and shippers, and Pest Control Advisers (PCAs) report as the major pest problems in cantaloupe and honeydew production along with a few minor pests that require careful monitoring. Data from the 1997 Annual Pesticide Use Report prepared by the Department of Pesticide Regulation has been used to estimate melon acreage treated with a material. Honeydews are not separately classified in the report indexed by commodities whereas cantaloupes are separated. Therefore, estimates for honeydew acreage treated with pesticides come from the melon section of the report.

Fruit and Foliage Pests

Silverleaf Whitefly, *Bemisia argentifolii*
Sweetpotato Whitefly, *Bemisia tabaci*

Melons are attacked by several different species of whiteflies, which are difficult to identify without the use of a hand lens, as they are small insects (1.5 mm). Whiteflies typically colonize the undersides of melon leaves where the eggs are laid. Whitefly nymphs feed on plant sap with sucking mouthparts. Whiteflies belong to the Family Aleyrodidae in the great Order of insects Homoptera. Whiteflies excrete copious amounts of a sticky substance called honeydew, which acts as a suitable substrate for the development of black, sooty mold. This leads to unmarketable fruit. Whitefly populations have inflicted serious crop losses in the past in the southern desert region, which led to a reduction in planted acres in Area III.

Control:
Chemical:

- **Imidacloprid (Admire 2F)**—Section 18 Emergency Exemption label states a 21 days preharvest interval (PHI) and a restriction that the material must be applied prior to plant growth of eight true leaves. Label has a rate of 0.25 lb a.i. per acre and a 12-hour reentry interval (REI). In 1997, median application rate was 0.25 lb a.i. per acre for cantaloupe and 0.18 lb a.i. per acre for honeydew. Approximately 37% of the cantaloupe and 28% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Systemic material works very well as a preventive for low populations. May be applied in drip irrigation. Imidacloprid is a category three material with a caution label. This material commonly offers control of all sucking insects for six to seven weeks when the material is properly applied.

- **Endosulfan (Thiodan 3EC, 50WP)**—Label has a rate of 0.5 to 1 lb a.i. per acre, a 2-day PHI and a 24-hour REI. In 1997, the median application rate was 0.94 lb a.i./acre for cantaloupe and 0.75 lb a.i./acre for honeydew. Approximately 17% of the cantaloupe and 29% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). The material is selectively used since a 300 foot buffer restriction applies to applications to fields that have drainage into waterways. Maximum application is 3 lb a.i./acre/year. Endosulfan is an excellent whitefly material but has restrictions regarding its use when irrigation water is running in the field. This insecticide is usually tank mixed with other materials. Endosulfan requires extremely careful handling as it has a danger poison label as a category one material.

- **Bifenthrin (Capture 2EC-Cal)**—Label has a rate of 0.075 to 0.1 lb a.i. per acre, a 7-day PHI and a 12-hour REI. In 1997, the median application rate was 0.08 lb a.i./acre for cantaloupe and 0.09 lb a.i./acre for honeydew. Approximately 14% of the cantaloupe and 35% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Section 18 registration requires a special permit from the county agricultural commissioner's office. Restricted to three applications per melon crop with only two applications allowed after bloom.

- **Dimethoate (Dimethoate 400, E267)**—Label has a rate of 0.5 lb a.i. per acre, a 3-day PHI and a 48-hour REI. In 1997, the median application rate was 0.33 lb a.i./acre for cantaloupe and 0.48 lb a.i./acre for honeydew. Approximately 6% of the cantaloupe and 29% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Dimethoate is listed as a severe hazard to bees, so caution must be exercised if beehives are placed in the area. Dimethoate is a category two material with a warning label and is frequently used as a cleanup spray prior to harvest due to the relatively short PHI.

- **Esfenvalerate (Asana XL)**—Label has a rate of 0.03-0.05 lb a.i. per acre, a 3-day PHI and a 12-hour REI. In 1997, the median application rate was 0.04 for both cantaloupe and honeydew. Approximately 15% of the cantaloupe and 18% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Efforts are made to reduce pest resistance to this product by including other materials of a different chemistry in a combination spray. Careful use of this
product is recommended, as extensive use may also lead to secondary pest problems with leafminers. Esfenvalerate is a category two material with a warning label.

- **Oxamyl (Vydate L)**—Label has a rate of 0.5 to 1 lb a.i. per acre, a 1-day PHI and a 48-hour REI. In 1997, the median application rate was 0.75 lb a.i./acre for cantaloupe and 0.7 lb a.i./acre for honeydew. Approximately 15% of the cantaloupe and 8% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Oxamyl is a systemic carbamate used postplant – if drip irrigation is used, this material can be injected into the irrigation system. Oxamyl is a category one material with a danger/poison label.

- **Permethrin (Pounce 3.2EC)**—Label has a rate of 0.1 to 0.2 lb a.i. per acre, a 0-day PHI and a 12-hour REI. In 1997, the median application rate was 0.13 lb a.i./acre for cantaloupe and 0.1 lb a.i./acre for honeydew. Approximately 8% of the cantaloupe and 15% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Permethrin is a category three material with a caution label. Do not apply more than 1.6 lb a.i./acre/season.

- **Azinphos methyl (Guthion 2L, Sniper 2E)**—Label has a rate of 0.5 lb a.i./acre. This organophosphate material has a 72-hour field reentry with differing PHI depending on label used and method of application. Less than 0.5% of the honeydew acreage was treated with azinphos methyl at a median application rate of 0.21 lb a.i./acre (1). Azinphos methyl has a category one label with a danger/poison designation. It can be applied by air or ground and carries a chemigation label on the Guthion 2L formulation. Caution must be used as there is a six month plant back restriction for root crops not on the label.

- **Potash Soap (M-Pede)**—Label has a rate of 1-2% solution (3.92-7.84 lb a.i./100 gallons total mix volume), 0-day PHI and 12-hour REI. Approximately 0.3% of the honeydew statewide acreage was treated with potash soap at a median application rate of 1.83 lb a.i./acre for honeydew. Potash soap was not used on cantaloupe (1). Thorough coverage is necessary, as this pesticide is a direct contact material. The material has adequate activity against nymphs but it is not very effective against adults. Complete foliage coverage is critical and is not easily achieved, thus insecticidal soaps are not used very much. Potash soap is a category three material with a caution label.

- **Neem Oil (Trilogy)**—Less than 1% of the melon statewide acreage is treated with this pesticide (1). Section 3 registration for the clarified hydrophobic extract 70% neem oil with a category three caution label. Ground application for thrips, mites, leafhopper, whitefly, and fungi control. Contact insecticides with no residual protection offer limited control of pests that can be blown in with the wind. As irrigation commences, ground rigs are unable to enter fields with contact materials.

**Biological:**
Several species of parasites and predators offer effective biological control of whiteflies if insecticide
applications don't drastically reduce or totally eliminate their numbers. Several species of ladybird beetles, including *Delphastus pusillus*, prey upon whiteflies. *Encarsia* and *Eretmocerus* wasp species parasitize some species of whiteflies but cannot be expected to control silverleaf whitefly populations in most situations.

**Cabbage Looper, *Trichoplusia ni***

The cabbage looper has become a problem in some melon production areas, especially in the San Joaquin Valley. Pest Control Advisers have reported that cabbage loopers have been showing up in greater numbers the last few years. Absence of long killing frosts and broad overlap of melon planting dates and numerous other vegetable host crops may be helping pest population buildup. Small instar larvae will chew on the bottom sides of melon leaves. Larger sized cabbage loopers are a threat to mature melon fruit as the worms chew on cantaloupe netting and can cause serious scarring on honeydew fruit. Fruit damaged by cabbage loopers can be scored as a defect by fruit inspectors and can lead to rejection if the damage is more than minimal.

Very few PCAs reported the use of pheromone traps for the monitoring of the pest though there is an effective pheromone attractant available for use.

**Control:**

**Chemical:**

- **Endosulfan** (Thiodan 3EC, 50WP)—Label has a rate of 0.5 to 1 lb a.i. per acre, a 2-day PHI and a 24-hour REI. In 1997, the median application rate was 0.94 lb a.i./acre for cantaloupe and 0.75 lb a.i./acre for honeydew. Approximately 17% of the cantaloupe and 29% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). The material is selectively used since a 300 foot buffer restriction applies to applications to fields that have drainage into waterways. This especially impacts the Merced, San Joaquin, and Sacramento growing regions. Maximum application is 3 lb a.i./acre/year. Endosulfan is an excellent material that has activity against looper larvae and adult moths. It does have restrictions regarding its use when irrigation water is running in the field.

- **Methomyl** (Lannate SP)—Label has a 1-day PHI for the application rate of 0.45 lb a.i. per acre and 3-day PHI for the application rate of 0.9 lb a.i. per acre. Worker reentry is 48 hours and would supersede the 1 day PHI. In 1997, the median application rate was 0.45 lb a.i./acre for both cantaloupe and honeydew. Approximately 22% of the cantaloupe and 20% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). It has been suggested that methomyl applications have caused *Liriomyza* leafminer outbreaks. Pest Control Advisers are generally concerned about causing secondary problems because leafminer populations can build
up fairly rapidly, so this compound is used judiciously.

- **Esfenvalerate** (Asana XL)—Label has a rate of 0.03-0.05 lb a.i. per acre, a 3-day PHI and a 12-hour REI. In 1997, the median application rate was 0.04 for both cantaloupe and honeydew. Approximately 15% of the cantaloupe and 18% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Efforts are made to reduce pest resistance to this product by including other materials of a different chemistry in a combination spray. Careful use of this product is recommended, as extensive use may also lead to secondary pest problems with leafminers.

- **B.t. Bacillus thuringiensis**—Label rates vary with choice of product but usually are in the 1 to 2 pound (0.05-0.21 lb a.i.) per acre range; 0-day PHI with a 4-hour field reentry.. In 1997, the median application rate was 0.06 for cantaloupe and 0.04 lb a.i./acre for honeydew. Approximately 25% of the cantaloupe and 11% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Oftentimes used in a tank mix, with a contact material such as methomyl, if larger-sized larval instars are present, as the material is most effective against smaller instar worms. Bt products are acceptable materials used in organic melon production.

**Biological:**
Some biological control of the cabbage looper takes place in melon fields from several parasites. Attempts to augment the natural predator and parasite complex with releases of beneficial insects and parasites for lepidopterous larval control has been very limited in scope and success. *Trichogramma pretiosum*, a parasite on lepidopteran eggs, is available from commercial insectaries for augmentative and inundative releases of eggs. Wasp eggs are released in a field for emergence of the wasp, which then lays its eggs into the looper eggs. Active parasitism can be monitored by looking for black, parasitized looper eggs during field inspections. A biological control program depends upon a dedicated PCA to oversee the project and to make sure that egg hatches are timed for looper moth oviposition and during the time period when mature fruit can be damaged. Growers must be willing or able to tolerate some fruit loss and avoid broad spectrum control materials. Very few growers and PCAs have actually had any experience in using augmentative or inundative releases.

**Yellow Striped Armyworm, Spodoptera ornithogalli**
Both growers and PCAs reported armyworm species that attack the fruit as a major threat to melon production fields. Pest monitoring becomes crucial as melon fruit size increases prior to harvest. Growers and PCAs involved in conventional fields generally do not regard Bts, applied without other materials in a tank mix, as effective control chemicals. Frequent applications are needed to time the pesticide when the pest is most vulnerable in the smaller instar stage. Organic growers report that Bts are very important in their melon fields as alternatives approved for organic production are limited. Crop damage consists of deep feeding holes into the melon flesh that makes the fruit unmarketable.
Control:

Chemical:

- **Methomyl** (Lannate SP)—1 day PHI for the application rate of 0.45 lb a.i. per acre and 3 day PHI for the application rate of 0.9 lb a.i. per acre. Worker reentry is 48 hours and would supersede the 1-day PHI. In 1997, the median application rate was 0.45 lb a.i./acre for both cantaloupe and honeydew. Approximately 22% of the cantaloupe and 20% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). It has been suggested that methomyl applications have been responsible for causing *Liriomyza* leafminer outbreaks. Pest Control Advisers are generally concerned about causing secondary problems because leafminer populations can build up fairly rapidly, so this compound is used judiciously. Methomyl still remains a very effective material for worm control and it is the material of choice when armyworms are on the move from weeds to melon fruit.

- **Esfenvalerate** (Asana XL)—Label has a rate of 0.03-0.05 lb a.i. per acre, a 3-day PHI and a 12-hour REI. In 1997, the median application rate was 0.04 for both cantaloupe and honeydew. Approximately 15% of the cantaloupe and 18% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Efforts are made to reduce pest resistance to this product by including other materials of a different chemistry in a combination spray. Careful use of this product is recommended, as extensive use may also lead to secondary pest problems with leafminers.

- **B.t. Bacillus thuringiensis**—Label rates vary with choice of product but usually are in the 1 to 2 pound (0.05-0.21 lb a.i.) per acre range; 0 days PHI with a 4-hour field reentry. In 1997, the median application rate was 0.06 for cantaloupe and 0.04 lb a.i./acre for honeydew. Approximately 25% of the cantaloupe and 11% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Oftentimes used in a tank mix, with a contact material such as methomyl, if larger-sized larval instars are present, as the material is most effective against small worms. Bt products are acceptable materials used in organic melon production.

- **Methamidophos** (Monitor 4)—Special Local Need registration (Sec. 24 C - CA-880021). Label has a rate of 0.5 to 1 lb a.i. per acre, a 14-day PHI and a 72-hour REI. In 1997, the median application rate was 0.81 lb a.i./acre for cantaloupe and 1.62 lb a.i./acre for honeydew. Approximately 4% of the cantaloupe and 6% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Pest Control Advisers report excellent results with this material. The insecticide requires extremely careful handling as it has a danger poison label as a category one material.

Biological:
Some biological control of the western yellow striped armyworm takes place in melon fields from several parasites. Attempts to augment the natural predator and parasite complex with releases of
beneficial insects and parasites for lepidopterous larval control has been very limited in scope. *Trichogramma pretiosum*, a parasite on lepidopteran eggs, is available from commercial insectaries for augmentative and inundative releases of eggs (10). Wasp eggs are released in a field for emergence of the wasp, which then lays its eggs into the armyworm eggs. Active parasitism can be monitored by looking for black, parasitized armyworm eggs during field inspections. A biological control program depends upon a dedicated PCA to oversee the project and to make sure that egg hatches are timed for armyworm moth oviposition and during the time period when mature fruit can be damaged. Growers must be willing or able to tolerate some fruit loss and avoid broad spectrum control materials. Very few growers and PCAs have actually had any experience in using augmentative or inundative releases. Those that have used biological control agents have reported successful reductions in pests. Minimal overall costs are involved and they are usually offset by a reduction in pesticide applications.

**Beet Armyworm, *Spodoptera exigua***

Both growers and PCAs reported armyworm species that attack the fruit as a major threat to melon production fields. Pest monitoring becomes crucial as melon fruit size increases prior to harvest. Armyworm larvae eat large holes into the melon flesh and make the fruit unmarketable. Bts were generally not regarded as effective control chemicals by growers and PCAs involved in conventional fields as the timing of applications based on larval instar stage is crucial in timing the pesticide to the stage of growth where the pest is most vulnerable. Armyworm is susceptible in the first three instars, making correct timing difficult and frequent applications costly. Coverage is critical and aerial application is often not adequate for stand alone control. Organic melon growers report that Bt products are very important in their production fields, as alternatives approved for organic production are limited. Releases of beneficial insects and parasites for lepidopterous larval control has been very limited in scope.

**Control:**

**Chemical:**

- **Methomyl** (Lannate SP) — 1 day PHI for the application rate of 0.45 lb a.i. per acre and 3 days PHI for the application rate of 0.9 lb a.i. per acre. Worker reentry is 48 hours and would supersede the 1-day PHI. In 1997, the median application rate was 0.45 lb a.i./acre for both cantaloupe and honeydew. Approximately 22% of the cantaloupe and 20% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). It has been suggested that methomyl applications have caused *Liriomyza* leafminer outbreaks. Pest Control Advisers are generally concerned about causing secondary problems because leafminer populations can build up fairly rapidly, so this compound is used judiciously. Methomyl is highly regarded as a worm killer and is frequently used to control armyworms on the move from weed species such as nightshade to melons when fruit approaches maturity.
- **Esfenvalerate** (Asana XL) — Label has a rate of 0.03-0.05 lb a.i. per acre, a 3-day PHI and a 12-hour REI. In 1997, the median application rate was 0.04 for both cantaloupe and honeydew. Approximately 15% of the cantaloupe and 18% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Efforts are made to reduce pest resistance to this product by including other materials of a different chemistry in a combination spray. Careful use of this product is recommended, as extensive use may also lead to secondary pest problems with leafminers.

- **B.t. Bacillus thuringiensis** — Application rates vary with choice of product but usually are in the 1 to 2 pound (0.05-0.21) per acre range; 0 days PHI with a 4-hour field reentry. In 1997, the median application rate was 0.06 for cantaloupe and 0.04 lb a.i./acre for honeydew. Approximately 25% of the cantaloupe and 11% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Oftentimes used in a tank mix, with a contact material such as methomyl, if larger sized larval instars are present as the material is most effective against small worms. Bt products are acceptable materials used in organic melon production.

- **Methamidophos** (Monitor 4) — Special Local Need registration (Sec. 24 C - CA-880021). Label has a rate of 0.5 to 1 lb a.i. per acre, a 14-day PHI and a 72-hour REI. In 1997, the median application rate was 0.81 lb a.i./acre for cantaloupe and 1.62 lb a.i./acre for honeydew. Approximately 4% of the cantaloupe and 6% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Pest Control Advisers report excellent results with this material. The insecticide requires extremely careful handling as it has a danger poison label as a category one material.

**Biological:**

Some biological control of beet armyworm takes place in melon fields from several parasites and a viral disease called nuclear polyhedrosis. *Hyposoter exiguae* is a parasitoid on beet armyworm. This wasp can reduce armyworm populations if pesticide use is kept at a minimum, as the natural predator and parasitoid complex will be reduced by applications. *Trichogramma pretiosum*, a parasite on lepidopteran eggs, is available from commercial insectaries for augmentative and inundative releases of eggs (10). The parasite is generally not as effective against armyworms as they are against other worm species due to the protective scales on the armyworm egg mass (11). Eggs are released in a field for emergence of the wasp, which then lays its eggs into the exposed armyworm eggs not protected from scales at the outer edges of the egg masses. Field personnel can monitor parasitism by looking for black, parasitized eggs during field inspections. A biological control program depends upon a dedicated PCA to oversee the project and to make sure that egg hatches are timed for moth egg laying and during the time period when melon fruit can be damaged by larvae feeding. Growers must be willing or able to tolerate some fruit loss and avoid broad spectrum control materials. Very few growers and PCAs have actually had any experience using augmentative or inundative releases.
Darkling Ground Beetles, *Blapstinus* spp., *Caelus* spp., and others

Darkling ground beetle adults can cause damage to melon flowers by feeding on the blossoms during bloom, eating plant tissue on the undersides of leaves, and by feeding on fruit as melons begin to ripen. Adult beetles also reduce stand by feeding on emerging seedlings.

**Control:**

**Chemical:**

- **Carbaryl** (Sevin 5)—Label has a rate of 1 lb a.i. per acre, a 0-day PHI and a 12-hour field reentry. In 1997, the median application rate was 1 lb a.i./acre for cantaloupe and 0.33 lb a.i./acre for honeydew. Approximately 14% of the cantaloupe and 23% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). An excellent insecticide that control darkling ground beetles, crickets and numerous other insect species such as earwigs. Bait can be placed out around the perimeter of a field, be applied by ground rigs or applied by aircraft. Treat when beetles are observed causing crop damage. Routine field inspections should be practiced to look for fruit and foliage pests especially as harvest time approaches.

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**Cucumber Beetles, *Diabrotica* spp.**

Cucumber beetles are considered a major pest to melons as they are a disease vector and can spread squash mosaic virus (10). Cucumber beetles have alternating stripes of black and yellow color on their back and are about 9 mm long (0.36 inch). Their feeding starts in the melon flowers which can be destroyed and then moves to leaves by chewing up large holes and then progresses to the young fruit where they chew on the fruit surface and cause scars.

**Control:**

**Chemical:**

- **Methomyl** (Lannate SP)—1 day PHI for the application rate of 0.45 lb a.i. per acre and 3 day PHI for the application rate of 0.9 lb a.i. per acre. Worker reentry is 48 hours and would supersede the 1 day PHI. In 1997, the median application rate was 0.45 lb a.i./acre for both cantaloupe and honeydew. Approximately 22% of the cantaloupe and 20% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). It has been suggested that methomyl applications have caused *Liriomyza* leafminer outbreaks. Pest Control Advisers are generally concerned about causing secondary problems because leafminer populations can build up fairly rapidly, so this compound is used judiciously.
- **Carbaryl** (Sevin 5)—Label has a rate of 1 lb a.i. per acre, a 0-day PHI with a 12-hour field reentry. In 1997, the median application rate was 1 lb a.i./acre for cantaloupe and 0.33 lb a.i./acre for honeydew. Approximately 14% of the cantaloupe and 23% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). An excellent insecticide that controls cucumber beetles and numerous other insect species such as darkling ground beetles, earwigs, and crickets. Bait can be placed out around the perimeter of a field, be applied by ground rigs or by aircraft. Treat when cucumber beetles are observed causing crop damage. Routine field inspections should be practiced to look for fruit and especially the fruit bottom side as harvest time approaches.

- **Endosulfan** (Thiodan 3EC, 50WP)—Label has a rate of 0.5 to 1 lb a.i. per acre, 2-day PHI and a 24-hour REI. In 1997, the median application rate was 0.94 lb a.i./acre for cantaloupe and 0.75 lb a.i./acre for honeydew. Approximately 17% of the cantaloupe and 29% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). The material is selectively used since a 300 foot buffer restriction applies to applications to fields that have drainage into waterways. This especially impacts the Merced, San Joaquin, and Sacramento growing regions. Maximum application is 3 lb a.i./acre/year. Endosulfan is an excellent material for control of adult beetles but it has restrictions regarding applications when irrigation water is running in the field.

- **Esfenvalerate** (Asana XL)—Label has a rate of 0.03-0.05 lb a.i. per acre, a 3-day PHI and a 12-hour REI. In 1997, the median application rate was 0.04 for both cantaloupe and honeydew. Approximately 15% of the cantaloupe and 18% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Efforts are made to reduce pest resistance to this product by including other materials of a different chemistry in a combination spray. Careful use of this product is recommended, as extensive use may also lead to secondary pest problems with leafminers.

- **Methamidophos** (Monitor 4)—Special Local Need registration (Sec. 24 C - CA-880021). Label has a rate of 0.5 to 1 lb a.i. per acre, a 14-day PHI and a 72-hour REI. In 1997, the median application rate was 0.81 lb a.i./acre for cantaloupe and 1.62 lb a.i./acre for honeydew. Approximately 4% of the cantaloupe and 6% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Pest Control Advisers report excellent results with this material. The insecticide requires extremely careful handling as it has a danger poison label as a category one material.

- **N-methyl Carbamate** (Adios)—It is applied as a bait at the rate of 0.5 to 0.75 pounds (0.065-0.098) per acre per application with a maximum use per season of 3.75 pounds (0.49 lb a.i.) per acre per growing season. Label has a 0-day PHI with a field reentry of 12 hours. Adios is a category three material with a caution label. Minimal statewide melon acreage is treated with this pesticide. No reported use in 1997 (1).
- **Azinphos methyl** (Guthion 2L, Sniper 2E)—Label has a rate of 0.5 lb a.i. per acre. This organophosphate material has a 72-hour field reentry with differing PHI depending on label used and method of application. Less than 0.5% of the honeydew acreage was treated with azinphos methyl at a median application rate of 0.21 lb a.i./acre (1). Azinphos methyl has a category one label with a danger/poison designation. It can be applied by air or ground and carries a chemigation label on the Guthion 2L formulation. Caution must be used, as there is a six-month plant back restriction for root crops not on the label.

**Stink Bugs**

Consperser stink bug, *Euschistus conspersus*

Green stink bug, *Nezara viridula* or *Acrosternum hilare*

Say's stink bug, *Chlorochroa sayi* (or *Pitedia sayi*)

Redshouldered stink bug, *Thyanta pallidovirens*

Uhler's stink bug, *Pitedia uhleri*

Stink bugs are occasional pests on melons and are a minor threat to melon fruit during the early and fairly soft stage of growth. As melon fruit reaches maturity and the rind hardens, damage potential is significantly reduced. Melons are damaged by stink bugs inserting their mouthparts into the fruit during feeding while secreting digestive fluids. Stink bugs have piercing and sucking mouthparts, which cause initial damage that appears as dark pinpricks as cellular fluid is extracted. Irregular blotches develop with spongy tissue below the spots. Immature fruit may develop irregular shapes and look distorted on the side where the stink bug inserted its mouthpart.

The various species of stink bugs are all similar in life cycles and all cause the same type of crop damage. The consperse stink bug is the most common species in California and is the most important species in the Sacramento and northern San Joaquin valleys (Area 1). Area 1 also has the southern green stink bug that has been fairly well controlled by an imported parasite. Say's and Uhler's stink bugs are commonly found on the West Side of the San Joaquin Valley (Area 2). Stink bugs are considered by many PCAs and growers as the hardest insect species to control when populations threaten a high value fruit or vegetable crop.

**Control:**

Treatments for stink bugs are generally more likely in honeydews for export to the Pacific Rim countries due to the very low threshold for damage. Stink bugs may be found hiding on the ground below plants and monitoring needs to be carried out in a careful manner to detect the adults before obvious feeding damage is noticed on the fruit. Some production areas may have just an occasional stink bug problem due to the migratory nature of the flying adults (10). Melon fields near creek beds, sloughs, or orchards need to be monitored along the borders especially in the Merced area where stink bugs become a problem to fresh market tomato and almond producers. There are two generations of stink bugs per year with most of the fruit damage coming from offspring from the migrating adults. Spotting on melon fruit
from stink bug feces may be the first sign of pest activity.

**Chemical:**

- **Endosulfan** (Thiodan)—Label has a rate of 0.5 to 1 lb a.i. per acre, a 2-day PHI and a 24-hour REI. In 1997, the median application rate was 0.94 lb a.i./acre for cantaloupe and 0.75 lb a.i./acre for honeydew. Approximately 17% of the cantaloupe and 29% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). This material is seldom used in furrow-irrigated fields, since the 300 foot buffer restrictions are in place for applications with drainage into waterways. This especially impacts growing regions of Merced, San Joaquin, and Sacramento Counties. Maximum application is 3 lb a.i./acre/year.

- **Dimethoate**—Label has a rate of 0.5 lb a.i per acre, a 7-day PHI and a 48-hour REI. In 1997, the median application rate was 0.33 lb a.i./acre for cantaloupe and 0.48 lb a.i./acre for honeydew. Approximately 6% of the cantaloupe and 29% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Dimethoate is listed as a severe hazard to bees, so caution must be exercised if beehives are placed in the area.

- **Esfenvalerate** (Asana)—Label has a rate of 0.03-0.05 lb a.i. per acre, a 3-day PHI and a 12-hour REI. In 1997, the median application rate was 0.04 for both cantaloupe and honeydew. Approximately 15% of the cantaloupe and 18% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Efforts are made to reduce pest resistance to this product by including other materials of a different chemistry in a combination spray. Careful use of this product is recommended, as extensive use may also lead to secondary pest problems with leafminers.

- **Imidacloprid** (Admire 2F)—Label rate is 0.25 lb a.i. per acre, a 21-day PHI and a 12-hour REI. In 1997, the median application rate was 0.25 lb a.i. per acre for cantaloupe and 0.18 lb a.i. per acre for honeydew. Approximately 37% of the cantaloupe and 28% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Systemic material works very well as a preventive for low populations. May be applied in drip irrigation. Section 18 Crisis Exemption expires on April 2, 2000. This material should not be applied with phosphate fertilizers.

- **Methamidophos** (Monitor 4)—Special Local Need registration (Sec. 24 C - CA-880021). Label has a rate of 0.5 to 1 lb a.i. per acre, a 14-day PHI and a 72-hour REI. In 1997, the median application rate was 0.81 lb a.i/acre for cantaloupe and 1.62 lb a.i./acre for honeydew. Approximately 4% of the cantaloupe and 6% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Pest Control Advisers report excellent results with this material and consider it the best pesticide for stink bug control since waterway restrictions prevent users from choosing endosulfan for most applications.

- **Potash Soap** (M-Pede)—Label has a rate of 1-2% solution (3.92-7.84 lb a.i./100 gallons total
mix volume), a 0-day PHI and 12-hour REI. Approximately 0.3% of the honeydew statewide acreage was treated with potash soap at a median application rate of 1.83 lb a.i./acre for honeydew. Potash soap was not used on cantaloupe (1). Thorough coverage is necessary, as this pesticide is a direct contact material. The material has adequate activity against nymphs but it is not very effective against adults. Complete foliage coverage is critical and is not easily achieved. Minimal statewide melon acreage is treated with insecticidal soap.

Cultural:
Pheromone trapping—Traps can be used in field monitoring to detect migrations of Conspere stink bug into melon fields if field history has shown a stink bug problem. Pest Control Advisers report poor results with the use of pheromone traps as a monitoring tool in mixed stink bug species populations. Erratic field data from low or no pests found in the traps when stink bugs were being found in the field is the prime concern. PCAs are commonly unsure of what species are being trapped and have stated that there needs to be a further look into monitoring moving populations. Some PCAs have said that the traps didn't tell them anything they already didn't know such as presence or absence of the pest. Mixed results have left users unwilling to trust the traps without extensive field investigations. University of California guidelines advise use of the trap as an indicator for initial migration of Conspere species only. While this is true, the lack of an attractant for Say's or redshouldered species reduces the trap utility to very limited areas.

Biological:
Some biological control of stink bugs takes place in melon fields from several parasites. Parasitized stink bug eggs may be found in clumps or clusters on the bottom sides of foliage.

Crickets, Numerous species in the Gryllid Family and Gryllotalpa Family

Field crickets (Gryllid) are occasional pests that can damage fruit as melons begin to ripen. Crickets can spot melons with their excrement, which results in dark brown exterior stains that affects market value. Mole crickets (Gryllotalpa) can damage irrigation equipment by chewing on drip lines. Mole crickets have modified digging organs that allow them to burrow into soil and disturb young seedlings as they feed upon tender melon roots.

Control:

Chemical:

- Carbaryl (Sevin)—Label has a rate of 1 lb a.i. per acre, a 0-day PHI with a 12-hour field reentry. In 1997, the median application rate was 1 lb a.i./acre for cantaloupe and 0.33 lb a.i./acre for honeydew. Approximately 14% of the cantaloupe and 23% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Carbaryl is an excellent insecticide that
control crickets and numerous other insect species such as darkling ground beetles. Bait can be placed out around the perimeter of a field, be applied by ground rigs or applied by aircraft. Treat when crickets are observed causing crop damage. Routine field inspections should be practiced to look for fruit and foliage pests especially as harvest time approaches.

- **Naled** (Dibrom 8)—This material has a danger label and it has a label rate of 0.9 to 1.8 lb a.i. per acre and a 1-day PHI. Reentry intervals are 48-hours for less than or equal to 0.9 lb a.i./acre and 72-hours for applications greater than 0.9 lb a.i./acre. In 1997, the median application rate was 1.01 lb a.i./acre for both cantaloupe and honeydew. Approximately 2% of the cantaloupe and 1% of the honeydew statewide acreage were treated with this pesticide in 1997 (1).

**European Earwig, *Forficula auricularia***

Earwigs are small insects about 1.25 to 2 cm long (0.5 to 0.75 inch) that have a pair of pincers at the rear end on their abdomen. Nymphs are the most destructive stage of the insect as they feed upon melons by boring small, deep holes into fruit. Crop damage from this minor pest is usually found on the bottom sides of fruit and often goes undetected unless field personnel check under melons during field inspections.

**Control:**

**Chemical:**

- **Carbaryl** (Sevin)—Label has a rate of 1 lb a.i. per acre, 0-day PHI with a 12-hour field reentry. In 1997, the median application rate was 1 lb a.i./acre for cantaloupe and 0.33 lb a.i./acre for honeydew. Approximately 14% of the cantaloupe and 23% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Carbaryl is an excellent insecticide that control earwigs and numerous other insect species such as darkling ground beetles and crickets. Bait can be placed out around the perimeter of a field, be applied by ground rigs or by aircraft. Treatment should be made when earwigs are observed causing crop damage. Routine field inspections should be practiced to look for fruit and especially the fruit bottom side along with foliage pests as harvest time approaches.

**Dried Fruit Beetles, *Carpophilus hemipterus***

Dried fruit beetles belong to the insect family Nitidulidae and are sometimes referred to as sap beetles. Adult beetles are small in size and range from 3 to 5 mm (0.1 to 0.2 inch) long. Adult beetles lay their eggs in fruit and crop damage arises when the larvae develop and feed on soft tissue. Dried fruit beetles
look for any entry into fruit from insect or mechanical injuries. This pest species is attracted to and multiplies in rotting fruit such as figs, grapes, citrus, or stone fruit. Cultural control efforts aimed at limiting or reducing nearby decaying fruit will reduce favorable conditions for the buildup of the fruit beetles. The adult beetles can fly downwind. Dried fruit beetles are usually controlled by other pesticide applications and thus are considered only an occasional pest.

Foliage Pests

Melon Aphid, *Aphis gossypii*

The melon aphid represents a species that has been notoriously viewed as a major pest that has been showing up in the San Joaquin and Sacramento Valleys on a regular basis every year, thus it has become the primary pest to control. This species is heat tolerant and effectively establishes itself on most melon varieties. Some hybrid cantaloupe varieties tolerate or suppress aphid populations. A combination of native biological control organisms and chemical controls targeted for other pests often fail to keep this pest from flaring up. This pest can carry and transfer numerous mosaic virus diseases during feeding. The mosaic viruses can cause extensive damage to the melon industry even if the aphid colonies are controlled. The aphid species also represents a major threat to cotton fields and the insect is oftentimes referred to as the cotton/melon aphid (11).

Control:

**Chemical:**

Aphids have sucking mouthparts that pierce the plant tissue during feeding. Systemic insecticides have been effective in aphid control but in most cases do not stop virus transmission from the aphid to the plant. Pest resistance is a very critical concern for growers and PCAs. The ability to rotate pesticides with different chemistries is a necessity in IPM programs for this pest.

- **Imidacloprid** (Admire)—Label rate is 0.25 lb a.i. per acre, a 21-day PHI and a 12-hour REI. In 1997, the median application rate was 0.25 lb a.i. per acre for cantaloupe and 0.18 lb a.i. per acre for honeydew. Approximately 37% of the cantaloupe and 28% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Systemic material works very well as a preventative for all sucking insects. The material is much more expensive than dimethoate, but few secondary pest problems arise. This pesticide may be applied in drip irrigation. The Section 18 Emergency Exemption requires a special permit from the county agricultural commissioner's office. This material must be applied prior to eight true leaf stage. Field reports indicate six weeks of aphid control in most cases. Imidacloprid usually runs out of activity several weeks prior to melon harvest which leads to a cleanup spray with a material, such as endosulfan, with a short PHI. The use of imidacloprid for whitefly control in the desert region (Area III) may have helped to control aphid populations, as this pest generally has not been a problem in the southern
• **Endosulfan** (Thiodan)—Label has a rate of 0.5 to 1 lb a.i. per acre, a 2-day PHI and a 24-hour REI. In 1997, the median application rate was 0.94 lb a.i./acre for cantaloupe and 0.75 lb a.i./acre for honeydew. Approximately 17% of the cantaloupe and 29% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). The material is selectively used since a 300 foot buffer restriction applies to applications to fields that have drainage into waterways. This especially impacts the Merced, San Joaquin, and Sacramento growing regions. Maximum application is 3 lb a.i./acre/year. Endosulfan is an excellent aphid material but has restrictions regarding its use when irrigation water is running in the field.

• **Diazinon**—Label has a rate of 0.25 to 0.75 lb a.i. per acre, a 3-day PHI and a 24 hour REI. In 1997, the median application rate was 0.5 lb a.i./acre for both cantaloupe and honeydew. Approximately 27% of the cantaloupe and 15% of the honeydew statewide acreage are treated with this pesticide (1). This product has been used for the control of several aphid species and works well when in combination with other materials. PCAs usually will tank mix this product due to the severity of damage caused by aphid colonies. The use of diazinon has increased since the elimination of mevinphos. Diazinon is used as a cleanup spray prior to harvest due to its quick breakdown in the environment. The material has activity even in dense canopies, which oftentimes is encountered in honeydew production.

• **Bifenthrin** (Capture)—Label has a rate of 0.075 to 0.1 lb a.i. per acre, a 7-day PHI and a 12-hour REI. In 1997, the median application rate was 0.08 lb a.i./acre for cantaloupe and 0.09 lb a.i./acre for honeydew. Approximately 14% of the cantaloupe and 35% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Restricted to three applications per melon crop with only two applications allowed after bloom. Section 18 registration requires a special permit from the county agricultural commissioner's office. Bifenthrin is considered to be disruptive to beneficial insects but has effective activity against aphids except when high air temperatures above 90 degrees Fahrenheit are encountered. This may be due to a change in aphid morphs.

• **Dimethoate**—Label has a rate of 0.5 lb a.i. per acre, a 3-day PHI and a 48-hour REI. In 1997, the median application rate was 0.33 lb a.i./acre for cantaloupe and 0.48 lb a.i./acre for honeydew. Approximately 6% of the cantaloupe and 29% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). The material has severe hazards to bees so caution must be exercised if beehives are placed in the area. Secondary pests such as leafminers are often associated with successive treatments of dimethoate. This product has both contact and systemic activity against aphids. The use of dimethoate for aphid control increased when mevinphos (Phosdrin) was eliminated.

• **Methomyl** (Lannate)—1 day PHI for the application rate of 0.45 lb a.i. per acre and 3 days PHI for the application rate of 0.9 lb a.i. per acre. Worker reentry is 48 hours and would supersede the
day PHI. In 1997, the median application rate was 0.45 lb a.i./acre for both cantaloupe and honeydew. Approximately 22% of the cantaloupe and 20% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). It has been suggested that methomyl applications have caused *Liriomyza* leafminer outbreaks. Pest Control Advisers are generally concerned about causing secondary problems because leafminer populations can build up fairly rapidly, so this compound is used judiciously.

- **Methamidophos** (Monitor)—Special Local Need registration (Sec. 24 C - CA-880021). Label has a rate of 0.5 to 1 lb a.i. per acre, a 14-day PHI and a 72-hour REI. In 1997, the median application rate was 0.81 lb a.i/acre for cantaloupe and 1.62 lb a.i./acre for honeydew. Approximately 4% of the cantaloupe and 6% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Pest Control Advisers report excellent results with this material. The insecticide requires extremely careful handling as it has a danger poison label as a category one material.

- **Naled** (Dibrom)—This material has a danger label and it has a label rate of 0.9 to 1.8 lb a.i. per acre and a 1-day PHI. Reentry intervals are 48-hours for less than or equal to 0.9 lb a.i./acre and 72-hours for applications greater than 0.9 lb a.i./acre. In 1997, the median application rate was 1.01 lb a.i./acre for both cantaloupe and honeydew. Approximately 2% of the cantaloupe and 1% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). The material is a hazard to bees but it is usually used as a cleanup spray prior to harvest due to its short PHI when bees have been removed from fields.

- **Potash Soap** (M-Pede)—Label has a rate of 1-2% solution (3.92-7.84 lb a.i./100 gallons total mix volume); 0-day PHI and 12-hour REI. Approximately 0.3% of the honeydew statewide acreage was treated with potash soap at a median application rate of 1.83 lb a.i./acre for honeydew. Potash soap was not used on cantaloupe (1). Thorough coverage is necessary as this pesticide is a direct contact material. Ground application needed but not often available due to irrigation schedules. The material has adequate activity against nymphs but it is not very effective against adults.

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**Leafhoppers, *Empoasca* spp**

Leafhoppers are small insects about 3 mm (0.12 inch) long that belong to the Order Homoptera. Leafhopper adults lay their eggs below the leaf surface. When the nymphs hatch, they move to the bottom sides of leaves where they feed by sucking on the plant sap. Feeding removes chlorophyll and as a result, melon leaves may turn yellow. Melon plants can tolerate fairly heavy feeding by leafhoppers providing the crop is not stressed for water and the pest is not present on the eight terminal leaves found on the runners. If leafhoppers are present on the leaves found at the ends of the runners, an insecticide application is warranted and action needs to be taken. Leafhoppers are considered a minor pest that is
usually controlled by pesticides applied for melon aphid control. Leafhoppers also do cosmetic damage by their excrement spotting the fruit of honeydews and other melon types that are smooth skinned and that lack netting like cantaloupes.

**Control:**

**Chemical:**
Leafhoppers have sucking mouthparts that pierce the plant tissue during feeding. Systemic insecticides have been effective in control. Injections into drip irrigation equipment can be made and are preferred over aerial or ground rig applications that spray all insect species present in a field and thus take out the beneficial predator and parasite complex.

- **Dimethoate**—Label has a rate of 0.5 lb a.i. per acre, a 3-day PHI and a 48-hour REI. Application rate was 0.33 lb a.i./acre for cantaloupe and 0.48 lb a.i./acre for honeydew. Approximately 6% of the cantaloupe and 29% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Dimethoate poses a severe hazard to bees so caution must be exercised if beehives are placed in the area. Secondary pests such as leafminers are often associated with successive treatments of dimethoate. This material has both contact and systemic activity against aphids. The use of dimethoate for aphid control increased when mevinphos was eliminated.

- **Imidacloprid** (Admire)—Label has a rate of 0.25 lb a.i. per acre, a 21-day PHI and a 12-hour REI. In 1997, the median application rate was 0.25 lb a.i. per acre for cantaloupe and 0.18 lb a.i. per acre for honeydew. Approximately 37% of the cantaloupe and 28% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Systemic material works very well as a preventive for all sucking insects. The material is much more expensive than dimethoate, but few secondary pest problems arise. May be applied in drip irrigation. Field reports indicate six weeks of aphid control in most cases. Imidacloprid usually runs out of activity several weeks prior to melon harvest which leads to a cleanup spray with a material such as endosulfan with a short PHI.

- **Endosulfan** (Thiodan)—Label has a rate of 0.5 to 1 lb a.i. per acre and a 2-day PHI. In 1997, the median application rate was 0.94 lb a.i./acre for cantaloupe and 0.75 lb a.i./acre for honeydew. Approximately 17% of the cantaloupe and 29% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Endosulfan is an excellent aphid material but it has restrictions regarding applications when irrigation water is running in the field.

- **Diazinon**—Label has a rate of 0.25 to 0.75 lb a.i. per acre, a 3-day PHI and a 24-hour REI. This product has been used for the control of several sucking insect species and works well when in combination with other materials. PCAs usually will tank mix this product due to the potential spotting damage to honeydew fruit caused by leafhoppers excrement. The use of diazinon has increased since the elimination of mevinphos. In 1997, the median application rate was 0.5 lb a.i./acre for both cantaloupe and honeydew. Approximately 27% of the cantaloupe and 15% of the
honeydew statewide acreage are treated with this pesticide.

- **Bifenthrin** (Capture)—Label has a rate of 0.075 to 0.1-lb a.i. per acre, a 7-day PHI and a 12-hour REI. Bifenthrin is considered to be disruptive to beneficial insects but has effective activity against aphids except when high air temperatures above 32 degrees Celsius (90 degrees Fahrenheit) are encountered. In 1997, the median application rate was 0.08 lb a.i./acre for cantaloupe and 0.09 lb a.i./acre for honeydew. Approximately 14% of the cantaloupe and 35% of the honeydew statewide acreage were treated with this pesticide in 1997 (1).

- **Esfenvalerate** (Asana)—Label has a rate of 0.03-0.05 lb a.i. per acre, a 3-day PHI and a 12-hour REI. In 1997, the median application rate was 0.04 for both cantaloupe and honeydew. Approximately 15% of the cantaloupe and 18% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Efforts are made to reduce pest resistance to this product by including other materials of a different chemistry in a combination spray. Careful use of this product is recommended, as extensive use may also lead to secondary pest problems with leafminers.

- **Methamidophos** (Monitor)—Special Local Need registration (Sec. 24 C - CA-880021). Label has a rate of 0.5 to 1 lb a.i. per acre, a 14-day PHI and a 72-hour REI. In 1997, the median application rate was 0.81 lb a.i./acre for cantaloupe and 1.62 lb a.i./acre for honeydew. Approximately 4% of the cantaloupe and 6% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Pest Control Advisers report excellent results with this material. The insecticide requires extremely careful handling as it has a danger poison label as a category one material.

- **Azinphos methyl** (Guthion, Sniper)—Label has a rate of 0.5 lb a.i. per acre. This organophosphate material has a 72-hour field reentry with differing PHI depending on label used and method of application. Less than 0.5% of the honeydew acreage was treated with azinphos methyl at a median application rate of 0.21 lb a.i./acre (1). Azinphos methyl has a category one label with a danger/poison designation. It can be applied by air or ground and carries a chemigation label on the Guthion 2L formulation. Caution must be used as there is a six month plant back restriction for root crops not on the label.

- **Potash Soap** (M-Pede)—Label has a rate of 1-2% solution (3.92-7.84 lb a.i./100 gallons total mix volume), 0-day PHI and 12-hour REI. Approximately 0.3% of the honeydew statewide acreage was treated with potash soap at a median application rate of 1.83 lb a.i./acre for honeydew. Potash soap was not used on cantaloupe (1). Thorough coverage is necessary, as this pesticide is a direct contact material. Ground application needed but not often available due to irrigation schedules. The material has adequate activity against nymphs but it is not very effective against adults.

- **Neem Oil** (Trilogy)—Less than 1% of the melon statewide acreage is treated with this pesticide
Leafminers

**Serpentine Leafminer, Liriomyza trifolii**

**Vegetable Leafminer, Liriomyza sativa**

and other species

Leafminers are small dipteran flies, 1.5 mm (0.06 inch) long, which can cause considerable damage to melon leaves as secondary pests. Adult females lay their eggs in leaf tissue. Larvae emerge inside the leaves and mine their way in narrow tunnels between the lower and upper leaf surfaces. As the larvae grow, the width of the tunnels increases. Leaves may dry out and yields can be reduced in moderate infestations. Under heavy pest pressure, plants may die and entire fields can be lost if not correctly protected with insecticides. Monitoring of surrounding crops should be undertaken through the growing season to watch for any exodus of leafminers out of tomato or cotton fields as the adults would migrate to melon fields late in the season. Numerous parasites usually keep leafminer populations in check (10). Pesticide applications for other pests can knock down the predator-parasite complex and allow leafminers to become a problem later in the season.

**Control:**

**Biological:**

*Diglyphus*, a parasitic wasp, can be effective in biological control of leafminers if they are not removed from the fields from pesticide applications targeted at other pests (11). *Diglyphus* is commercially available and has been used as a biological control agent in greenhouses but there has been limited experience with releases into melon production fields (14).

**Chemical:**

Systemic insecticides have effectively controlled Leafminers. Ground rig applications usually provide better coverage and are preferred over aerial applications. Treatments should only be made if necessary as it is important to try and preserve the beneficial predator and parasite complex present in a field.

- **Dimethoate**—Label has a rate of 0.5 lb a.i. per acre, a 3-day PHI and a 48-hour REI. In 1997, the median application rate was 0.33 lb a.i./acre for cantaloupe and 0.48 lb a.i./acre for honeydew. Approximately 6% of the cantaloupe and 29% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Severe hazards to bees so caution must be exercised if beehives...
are placed in the area. Successive treatments of dimethoate should be avoided as repeated applications of the same material can lead to pest resistance to the insecticide. Rotate materials of different chemistries if multiple application are needed for adequate control.

- **Oxamyl** (Vydate) — Label has a rate of 0.5 to 1 lb a.i. per acre, a 1-day PHI and a 48-hour REI. In 1997, the median application rate was 0.75 lb a.i./acre for cantaloupe and 0.7 lb a.i./acre for honeydew. Approximately 15% of the cantaloupe and 8% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Oxamyl is a carbamate used postplant and can be injected into a drip irrigation system. Pest resistance to oxamyl has been recorded in some areas of the world especially with *L. trifolii* species. Restriction states not to use more than 3 gallons of product per season.

- **Abamectin** (Agri-Mek) — Label has a rate of 0.0093-0.019 lb a.i. per acre and a 7-day PHI. In 1997, the median application rate was 0.01 lb a.i./acre for both cantaloupe and honeydew. Approximately 15% of the cantaloupe and 9% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Applications were previously limited to ground applications only but an aerial application label has been recently added. This will help in the correct timing of applications once furrow irrigation water has been applied, which previously eliminated the opportunity for ground rig applications across wet soil. Multiple applications need to be based on a 7 to 10 day period to offer adequate control to new and emerging plant growth. If pest pressure occurs early in the season, a band application can be made. Agrimek is an excellent material that controls spider mites and leafminers.

- **Methamidophos** (Monitor) — Special Local Need registration (Sec. 24 C - CA-880021). Label has a rate of 0.5 to 1 lb a.i. per acre, a 14-day PHI and a 72-hour REI. In 1997, the median application rate was 0.81 lb a.i./acre for cantaloupe and 1.62 lb a.i./acre for honeydew. Approximately 4% of the cantaloupe and 6% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Pest Control Advisers report excellent results with this material. The insecticide requires extremely careful handling as it has a danger poison label as a category one material.

- **Azinphos methyl** (Guthion) — Label has a rate of 0.5 lb a.i. per acre. This organophosphate material has a 72-hour field reentry with differing PHI depending on label used and method of application. Less than 0.5% of the honeydew acreage was treated with azinphos methyl at a median application rate of 0.21 lb a.i./acre (1). Azinphos methyl has a category one label with a danger/poison designation. It can be applied by air or ground and carries a chemigation label on the Guthion 2L formulation. Caution must be used as there is a six-month plant back restriction for root crops not on the label.

- **Cyromazine** (Trigard) — Label has a 0-day PHI with 12-hour field reentry. This material is an insect growth regulator that offers effective control of leafminers if applied at the proper time before pest populations get out of control. The material is applied by aircraft at the rate of 0.125
lb a.i. per acre with a maximum of 6 applications per season. Cyromazine has a category three caution label. Less than 1% of the statewide melon acreage is treated with this pesticide as special restrictions are in place to monitor and schedule irrigations in fields treated with Trigard due to groundwater contamination concerns in identified Pest Management Zones (PMZs). The restricted use of this material needs to be cleared through the local county agricultural commissioner's office.

Spider Mites, *Tetranychus spp*

Spider mites are microscopic and can be seen with the aid of a 15-power hand lens. Mites prefer warm air temperatures and under ideal conditions they can reproduce in five to seven days. Spider mites produce a thick webbing material that led to the naming associated with spiders. Mites feed upon chlorophyll and their feeding results in a stippling of leaves with a loss of color and eventual drying as the leaves die. Spider mite colonies thrive under dusty conditions and traffic along roads can throw up considerable amounts of dust that lands on the crop canopy. This dust drives numerous species of predators away from the field borders as the beneficial insect species move away from the dusty foliage and migrate into the center of the field. Water should be dropped onto surrounding dusty roads that border fields to limit and prevent the unwanted dust in the air.

Control:

Biological:

There are several insect species that prey upon spider mites and these beneficial predators should be monitored before pesticide applications are made to assess the true situation. Thrips, ladybird beetles, lacewing larvae, and minute pirate bugs all are known predators of spider mites. In addition to these predatory insects, there may be predacious mites feeding on the spider mite eggs. Biological control efforts will be enhanced if pesticide applications were applied through the drip irrigation systems for control of sucking insects.

Chemical:

- **Abamectin** (Agri-Mek)—Label has a rate of 0.0093-0.019 lb a.i. per acre and a 7-day PHI. Band applications can be made for protection of early plant growth. In 1997, the median application rate was 0.01 lb a.i./acre for both cantaloupe and honeydew. Approximately 15% of the cantaloupe and 9% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Multiple applications need to be based on a 7 to 10 day period to offer adequate control to new and emerging plant growth. If pest pressure occurs early in the season, a band application can be made. Agri-mek is an excellent material that controls spider mites and leafminers.

- **Dicofol** (Kelthane 35)—Label has a rate of 0.35-0.58 lb a.i./acre, a 2-day PHI and a 12-hour REI.
In 1997, the median application rate was 0.44 lb a.i./acre for cantaloupe and 0.46 lb a.i./acre for honeydew. Approximately 18% of the cantaloupe and 15% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Ground applications usually get better results that aerial application of dicofol. It is important to use a spreader-sticker adjuvant in the tank mix. Dicofol is a category two pesticide with a warning label that cannot be used more than two times per season. Best results occur with applications timed when mite buildup appears but before extensive webbing is apparent as good coverage is essential for pest control.

- **Sulfur** (Dusting Sulfur)—1 day PHI. Label rate varies from 15 to 25 lb per acre depending upon manufacturer and formulation. In 1997, the median application rate was 18 lb a.i./acre for both cantaloupe and honeydew. Approximately 27% of the cantaloupe and 14% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Sulfur has been used for pest control of mites on melon varieties that are not sensitive to sulfur as leaf burning and dieback have been associated with some melon varieties. Check with the local seed company representatives for information on sulfur tolerance. Sulfur has been used to suppress spider mite colonies in melon fields and for control of powdery mildew. Sulfur has a fire hazard associated with its use at air temperatures above 35 degrees Celsius (95 degrees Fahrenheit) and extreme caution needs to be employed when air temperatures are close to that mark. Dusting sulfur is the preferred form and not wettable sulfur.

- **Neem Oil** (Trilogy)—Less than 1% of the melon statewide acreage is treated with this pesticide (1). The material is a clarified hydrophobic extract 70% Neem oil with a category three (3) caution label on a Section 3 registration. Ground application with extremely good coverage is necessary for control of thrips, mites, leafhopper, whitefly, and fungal pathogens. Melon foliage growth is very rapid with an average time period in the main season of 11 weeks from plant to harvest. Contact insecticides with no residual protection offer limited control of pests that can be blown in with the wind. As irrigation commences, ground rigs are unable to enter fields with contact materials.

### Seed and Seedling Pests

#### Cutworms

Several species of cutworms can become problems during seed germination and seedling emergence. Black cutworms and variegated cutworms are larvae of the *Noctuid* family of moths. Both of these moth species are being monitored in pheromone traps as part of a research project funded by the California Melon Research Board in Fresno, San Joaquin, Merced, and Sacramento Counties. Trap data is collected and disseminated in a cross commodity program whereby trap data is being shared with the Fresh Market Tomato industry. These two cutworm species are two of six different moth species being trapped in a network of over 80 pheromone traps set up across the San Joaquin Valley. The short-term intention
of the project is to monitor male moth flight activity and identify regional moth flights to alert PCAs and field personnel when a potential pest problem has been detected so that field monitoring activities can be implemented. The long-term intention of the project is to collect regional data to be used in insect degree day model validation.

Large larvae about 3.7 cm (1.5 inches) long can be found in debris in the topsoil of fields. Cutworms cut off plants at the soil surface and can reduce stand. Management strategy is to avoid planting into fields with plant residues or fields coming out of pastures if adequate time has not been provided to allow for breakdown and decomposition of organic debris. Cutworms generally can become a problem in late June or early July melon plantings following barley or wheat harvests.

Control:

Chemical:

- **Carbaryl** (Sevin)—Label has a rate of 1 lb a.i. per acre, 0 days PHI and a 12 hour field reentry. In 1997, the median application rate was 1 lb a.i./acre for cantaloupe and 0.33 lb a.i./acre for honeydew. Approximately 14% of the cantaloupe and 23% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). An excellent insecticide that control cutworms and numerous other insect species such as darkling ground beetles, earwigs, and crickets. Bait can be placed out around the perimeter of a field, be applied by ground rigs or by aircraft. Treat when cutworms are observed causing crop damage. Routine field inspections should be practiced to look for cutworms under soil clods on the ground surface when plants are found cut off and laying on the ground or when bare spots are encountered in the field.

- **Methomyl** (Lannate)—1 day PHI for the application rate of 0.45 lb a.i. per acre and 3 day PHI for the application rate of 0.9 lb a.i. per acre. Worker reentry is 48 hours and would supersede the 1-day PHI. In 1997, the median application rate was 0.45 lb a.i./acre for both cantaloupe and honeydew. Approximately 22% of the cantaloupe and 20% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Pest Control Advisers use this compound judiciously for cutworm control.

- **Esfenvalerate** (Asana)—Label has a rate of 0.03-0.05 lb a.i. per acre, a 3-day PHI and a 12-hour REI. In 1997, the median application rate was 0.04 for both cantaloupe and honeydew. Approximately 15% of the cantaloupe and 18% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Efforts are made to reduce pest resistance to this product by including other materials of a different chemistry in a combination spray. Careful use of this product is recommended, as extensive use may also lead to secondary pest problems with leafminers.

- **Permethrin** (Pounce)—Label has a rate of 0.1 to 0.2 lb a.i. per acre, a 0-day PHI and a 12-hour REI. In 1997, the median application rate was 0.13 lb a.i./acre for cantaloupe and 0.1 lb a.i./acre...
for honeydew. Approximately 8% of the cantaloupe and 15% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Permethrin is a category three material with a caution label.

- **Methamidophos (Monitor)—**Special Local Need registration (Sec. 24 C - CA-880021). Label has a rate of 0.5 to 1 lb a.i. per acre, a 14-day PHI and a 72-hour REI. In 1997, the median application rate was 0.81 lb a.i/acre for cantaloupe and 1.62 lb a.i./acre for honeydew. Approximately 4% of the cantaloupe and 6% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Pest Control Advisers report excellent results with this material. The insecticide requires extremely careful handling as it has a danger poison label as a category one material.

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**Seedcorn Maggots, Delia platura**

These two pests occasionally become a problem in cooler periods during spring when seeds are germinating in cool and wet soils. They attack emerging seedlings and can reduce stand. Fumigation and soil solarization can be used to control these soil residing pests. Seedcorn maggots are pupating larvae of a Dipteran fly that deposits its eggs in the soil around organic matter. Wireworms are larvae of click beetles and are also found in the soil.

**Control:**

**Chemical:**

- **Diazinon—** The granular formulation has a caution - category 3 label. It has a label rate of 3-4 lb a.i. per acre and a 12-hour REI. This material is broadcast and incorporated into soil if a wireworm or seedcorn maggot population is found prior to seeding. The liquid formulation of diazinon has a label has a rate of 0.75 to 1.0 lb a.i. (3 to 4 quarts of product) per acre and a 24-hour REI. This material can be applied to the soil with the seed in the drill row at planting to offer protection from seed pests. In 1997, the median application rate of diazinon was 0.5 lb a.i./acre for both cantaloupe and honeydew. Approximately 27% of the cantaloupe and 15% of the honeydew statewide acreage are treated with this pesticide (1).

- **Lindane (Isotox, Gamma Mean)—**12 hour field reentry. This restricted use material can be applied as a dust with the seed in the drill row at planting to offer protection from seed pests. Applications in precision air planters have resulted in fair control at best as the material needs to get into the soil without being held back in vacuum hoses and tubes. Application rate is 4 oz. (0.06 lb a.i.) per 100 lb of seed for cantaloupes. Some formulations are not labeled for honeydews. The liquid formulation of lindane is a restricted use material can be incorporated to the soil above the seed in the drill row at planting to offer protection from seed pests. Band
applications have been used during cool and wet spring weather when melon germination is slow and the risk of damage from seed pests is high. Caution must be used by the applicator to prevent applications directly onto seeds as germination and subsequent plant growth may be impacted. Approximately 4% of the cantaloupe and 9% of the honeydew statewide acreage were treated in 1997 with various formulations of this pesticide (1).

Wireworms, *Limonius spp.*

Wireworms occasionally become a problem in cooler periods during spring when seeds are germinating in cool and wet soils. They attack emerging seedlings and can reduce stand. Fumigation and soil solarization can be used to control these soil residing pests. Seedcorn maggots are pupating larvae of a Dipteran fly that deposits its eggs in the soil around organic matter. Wireworms are larvae of click beetles and are also found in the soil.

Control:

Chemical:

- **Diazinon**—The granular formulation has a caution - category 3 label. It has a label rate of 3-4 lb a.i. per acre and a 12-hour REI. This material is broadcast and incorporated into soil if a wireworm or seedcorn maggot population is found prior to seeding. The liquid formulation of diazinon has a label has a rate of 0.75 to 1.0 lb a.i. (3 to 4 quarts of product) per acre and a 24-hour REI. This material can be applied to the soil with the seed in the drill row at planting to offer protection from seed pests. In 1997, the median application rate of diazinon was 0.5 lb a.i./acre for both cantaloupe and honeydew. Approximately 27% of the cantaloupe and 15% of the honeydew statewide acreage are treated with this pesticide.

- **Lindane** *(Isotox, Gamma Mean)—12 hour field reentry. This restricted use material can be applied as a dust with the seed in the drill row at planting to offer protection from seed pests. Applications in precision air planters have resulted in fair control at best as the material needs to get into the soil without being held back in vacuum hoses and tubes. Application rate is 4 oz. (0.06 lb a.i.) per 100 lb of seed for cantaloupes. Some formulations are not labeled for honeydews. The liquid formulation of lindane is a restricted use material can be incorporated to the soil above the seed in the drill row at planting to offer protection from seed pests. Band applications have been used during cool and wet spring weather when melon germination is slow and the risk of damage from seed pests is high. Caution must be used by the applicator to prevent liquid applications directly onto seeds as germination and subsequent plant growth may be impacted. Approximately 4% of the cantaloupe and 9% of the honeydew statewide acreage are treated in 1997 with various formulations of this pesticide (1).
Melon production can be impacted by numerous biotic diseases caused by plant pathogens as well as abiotic diseases caused by stress from environmental factors or from toxic substance exposure (e.g., ozone injury). Biotic diseases represent the most serious threat to melons. Plant pathogens can be soil-borne or air-borne and consist of bacteria, fungi, and viruses. Irrigation management and soil drainage play important roles in reducing the threat from some plant diseases. In general, melons should be planted on high raised beds that allow for quick drainage and good aeration of the soil. Also, excessive soil moisture exacerbates problems with diseases of foliage and fruit because of increased humidity; this is why sprinkler irrigation is not used late in the growing season.

Viral Diseases: Cucumber Mosaic Virus (CMV), Watermelon Mosaic Virus (WMV), Zucchini Yellow Mosaic Virus (ZYMV), Squash Mosaic Virus, Cucurbit Aphid-Borne Yellows Virus (CABYV), Curly Top Virus and others

There are numerous viral diseases that can become problems in melon production. All of the virus diseases are insect transmitted, generally by aphids, some by whiteflies, and others by cucumber beetles and leafhoppers. Squash mosaic virus can be seed borne (11). Levels of infestation vary greatly year to year, ranging from mild to severe. Attempts to control the insect vectors with insecticides to control the disease have not been successful. Destruction of alternate hosts, weeds and old crops, can aid in area-wide management of viral diseases. Silver colored, reflective mulch has been effective against aphids in research trials but the high cost of the material and application has limited this option in pest control. The mulch apparently confuses the aphid as it flies over an area and does not land as sunlight is reflected off the mulch surface. Crop losses from viral diseases can be very severe in the San Joaquin Valley, especially in the later plantings targeted for a fall harvest. When viruses impact on a melon field, it is very common to find a complex with several pathogens attacking the crop (11). Combinations of CMV, WMV, and ZYMV are commonly found in lab analysis of infected plants.

Powdery Mildew, *Sphaerotheca fuliginea*

Initial symptoms are small yellow lesions on foliage. The spots enlarge and become covered with white powdery spores. Leaves eventually turn brown and dry. Growers and PCAs report that powdery mildew is a disease that is expressed when the crop is stressed by environmental factors such as mild air temperatures combined with high relative humidity, in the presence of a thick, dense canopy and can quickly spread across an entire field. Weed species are over-wintering hosts for powdery mildew (11). The disease can appear in most melon production regions of California.
Control:

Chemical:

- **Sulfur** (Dusting Sulfur)—Label states a 0-day PHI with 12-hour field reentry. Label rates vary with the manufacturer but 20 to 30 pounds per acre are common. In 1997, the median application rate was 18 lb a.i./acre for both cantaloupe and honeydew. Approximately 27% of the cantaloupe and 14% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Multiple preventive applications are usually required if favorable environmental conditions occur. Aerial operators make most applications. Only used with sulfur resistant varieties, as severe crop loss will occur from leaf burning if sulfur is applied to sensitive melon varieties.

- **Myclobutanil** (Rally)—Label has a rate of 0.1 lb a.i./acre, a 1-day PHI and a 48-hour field reentry. In 1997, the median application rate was 0.10 lb a.i./acre for both cantaloupe and honeydew. Approximately 17% of the cantaloupe and 21% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). Specific statewide Section 18 material requires special permit from county agricultural commissioner's office prior to use. Section 18 expires December 1, 1999.

- **Triadimefon** (Bayleton)—In 1997, the median application rate was 0.11 lb a.i./acre for cantaloupes and 0.10 lb a.i./acre for honeydew. Approximately 7% of the cantaloupe and 13% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). The use of triadimefon for powdery mildew control has been greatly reduced because the label explicitly states that the product does not adequately control the genus *Spaerotheca* (6), which is the predominant species of mildew found in melons grown in California (11). Growers would consider using a tank mix of this material with Benomyl until the pesticide label was reissued in 1998 with cucurbits being removed from the label.

- **Benomyl** (Benlate)—Label has a rate of 0.25 lb a.i. per acre, a 1-day PHI and a 24-hour REI. In 1997, the median application rate was 0.25 lb a.i./acre for cantaloupe and 0.24 lb a.i./acre for honeydew. Approximately 7% of the cantaloupe and 12% of the honeydew statewide acreage were treated with this pesticide in 1997 (1).

Cultural:

Best growing practices aimed at minimizing plant stress are suggested to reduce impact from the plant pathogen and to avoid over-watering which leads to a dense canopy over furrows, which is commonly the first site of infection. Resistant varieties are available.

Fusarium Wilt, *Fusarium oxysporum f. sp. melonis*
This root rot disease causes wilting of individual runners (vines) which can lead to collapse of the whole plant, especially after fruit set. The disease is recognized by the presence of lesions on the roots and a discolored vascular system. The pathogen is known to survive in the soil for 20 years. This pathogen species is only a disease of melons and has no known weed hosts (11).

**Control:**

**Chemical Control:**
None recommended, soil fumigation with methyl bromide or chloropicrin will control this disease but the cost is considered too high.

**Cultural:**
Several resistant varieties are available. Steam cleaning of equipment coming from infested fields is recommended.

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Damping off is a seedling disease caused by several fungi. Lesions usually develop at or below the soil line. They may girdle the hypocotyl or taproot, killing the seedling (11). *Pythium, Phytophthora, and Rhizoctonia* are generally associated with cool, wet soil, although there are heat tolerant *Pythium* species in the southern deserts that can infect fall sown crops. The other diseases are more limited in distribution, but can be severe.

**Control:**

**Chemical:**

- **Metalaxyl**—Label had a rate of 1-2 lb a.i./acre, a 5-day PHI and a 12-hour REI (metalaxyl products are no longer registered). Effective on *Pythium* and *Phytophthora* as a soil drench or at planting treatment. In 1997, the median application rate was 0.25 lb a.i./acre for both cantaloupe and honeydew. Approximately 5% of the cantaloupe acreage and less than 1% of the honeydew statewide acreage were treated with this pesticide in 1997 (1).

- **Benomyl** (Benlate)—Label has a rate of 0.25 lb a.i. per acre, a 1-day PHI and a 24-hour REI. Used as an in-furrow treatment at planting for *Acremonium* seedling root rot and *Fusarium*. Benlate has a caution- category 3 label. In 1997, the median application rate was 0.25 lb a.i./acre for cantaloupe and 0.24 lb a.i./acre for honeydew. Approximately 7% of the cantaloupe and 12% of the honeydew statewide acreage were treated with this pesticide in 1997 (1).
Cultural:
Sow melons on high beds with good drainage. In Area II, planting melons after the soil temperature exceeds 70 F will generally avoid problems. Acremonium can be managed by planting seed shallowly (about 0.5 inch) and irrigating for germination. Seedlings infested with Fusarium can recover if the soil surface is kept moist to encourage secondary roots. Thielaviopsis is avoided by planting when soil is warm.

**Downy Mildew, Pseudoperonospora cubensis**

This fungal pathogen is carried by air currents and becomes a problem during cool and wet weather patterns (7). The lower leaf surface may become covered with small, angular spots with a mottled appearance. Disease symptoms are usually first expressed on older leaves. Downy mildew attacks all cucurbits. Growers should avoid the use of any overhead irrigation during conditions that favor this disease (11).

**Control:**

**Chemical:**

- **Metalaxyl** (Ridomil)—Label had a rate of 1-2 lb a.i./acre, a 5-day PHI and a 12-hour REI (metalaxyl products are no longer registered). Apply when disease symptoms first appear and repeat if needed. Application rate is 2 lb product per acre. In 1997, the median application rate was 0.25 lb a.i./acre for both cantaloupe and honeydew. Approximately 5% of the cantaloupe and less than 1% of the honeydew statewide acreage were treated with this pesticide in 1997 (1).

- **Chlorothalonil** (Bravo)—Label has a rate of 1.17-1.43 lb a.i. per acre and a 48-hour REI. In 1997, the median application rate was 1.44 lb a.i./acre for cantaloupe and 1.57 lb a.i./acre for honeydew. Less than 1% of the cantaloupe and 5% of the honeydew statewide acreage were treated with this pesticide in 1997 (1).

- **Mancozeb** (Dithane)—Label has a rate of 1.6 to 2.4 lb a.i. per acre, 5-day PHI and a 24-hour REI. In 1997, the median application rate was 1.25 lb a.i./acre for cantaloupe. Less than 1% of the statewide cantaloupe acreage was treated with this pesticide in 1997. No use was reported on honeydew (1).

**Monosporascus Root Rot, Monosporascus cannonballus**
This root rot tolerates high temperatures and has killed whole fields in the southern desert areas, but is not yet a serious problem in other areas of California. This pathogen has been of minor concern in the melon production region of the San Joaquin Valley but it has been suspected as the causal agent of a few fields diagnosed with vine decline. It is apparently capable of surviving on a variety of crops but only causes symptoms on melons. No control practices are currently recommended (11).

**Verticillium Wilt, *Verticillium dahliae***

This is a widespread soil pathogen in California and infects many species of plants, including all cucurbits. Symptoms are wilting of runners caused by the fungus plugging xylem tissue, which can progress slowly through the whole plant. Infections generally begin when soil temperatures are cool, but symptoms occur when the temperatures are warm and the crop is under stress (7). No chemical controls are recommended. Soil fumigation with methyl bromide or chloropicrin will control this disease, but the cost is considered too high. Most cantaloupe and honeydew varieties have moderate to better resistance to *Verticillium*. Fields with high levels of disease inoculum should be avoided; cotton rotations are especially risky (11).

**Measles**

This is an abiotic disease of smooth skinned melons (honeydews) caused by guttation. The disease is a water soaking injury that is enhanced when melons contact wet soil for extended periods. Keeping the soil surface under the melon dry and reducing irrigations during fall periods controls it (11). No chemical control practices are implemented.

**Nematodes**

**Root knot nematode, *Meloidogyne spp.***

Nematodes are microscopic, unsegmented roundworms that live in soil and inside plant roots. Root knot nematode, *Meloidogyne incognita*, is the major species of nematode of economic importance to melon production in California. While there are other species of root knot nematodes present in California soils, *M. incognita* is among the most common. These parasites feed upon plant roots and produce swelling in the area of feeding. It is at this site of feeding where galls are formed which then may grow
to as large as an inch in diameter. The formation of galls in roots disrupts the flow of water and nutrients in the plant. This leads to stress, which can become quite severe during hot weather, especially when fruit is developing. Plants infested with root knot nematodes are less vigorous and don't respond to fertilizer as well as healthy plants. Nematodes attack numerous host plants and weeds. Sexual mating is not required for reproduction and individuals can survive without a host for a period of a year or longer. Population increases are dependent upon several factors such as local climate, soil type, and the number of overwintering nematodes present in the spring. The life cycle may be as fast as three or four weeks when warm weather and moist soil conditions are present. High numbers of nematodes may build up in sandy soils where significant crop loss can be expected in susceptible host plants. Nematodes can cause a plant to develop shallow root systems with numerous laterals that cannot match evapotranspiration demands during hot temperatures.

**Control:**

Knowledge of approximate population size and distribution across a field can help in choosing nematode control strategies. Soil samples can be collected in the field and transported to a nematode-testing laboratory for analysis of *Meloidogyne* spp (11). If damaging levels of nematodes are found in the lab analysis, several control strategies can be implemented.

**Chemical:**

- **Metam Sodium** (Soil Prep, Vapam, Sectagon)—Methylcarbamodithioic acid is a biocide that is used as a preplant material at various rates (50 to 100 gallons per acre) depending on the width of the planting bed that is treated. Metam sodium is commonly applied through sprinkler irrigation, as shank injection applications have not adequately suppressed nematode populations. Label restrictions are in place regarding the 14-day waiting period from application to melon planting to prevent seed germination problems. Soil moisture needs to be at or near field capacity for metam sodium to work properly. In 1997, the median application rate was 53 lb a.i./acre for cantaloupe and 19 lb a.i./acre for honeydew. Approximately 8% of the cantaloupe and 4% of the honeydew statewide acreage were treated in 1997 (1).

- **Oxamyl** (Vydate)—Label rate of 0.5 to 1 lb a.i. per acre, a 1-day PHI and a 48-hour REI. In 1997, the median application rate was 0.75 lb a.i./acre for cantaloupe and 0.7 lb a.i./acre for honeydew. Approximately 15% of the cantaloupe and 8% of the honeydew statewide acreage were treated with this pesticide in 1997 (1). This carbamate is used as a preplant material or postplant if drip irrigation is used. Oxamyl can be shank injected along both sides of the plant row at planting to get the material into the plant as soon as possible as galls can be formed within a month of planting. Injection of the material into drip irrigation lines would require multiple applications to offer protection across the growing season. Different species of root knot nematodes have been known to occur together in a field. Their life histories and crop damage are similar. This becomes an important issue if the Javanese root knot nematode, *M. javanica*, is present along with *M. incognita*. The oxamyl label states that *M. javanica* is not controlled
though *M. incognita* is controlled (6). This illustrates the importance of knowing which pest species are present before using a pesticide application. No single chemical control tactic when used alone will totally eliminate nematode populations.

- **Chloropicrin**—A preplant material used with plastic tarps immediately after application to the soil. A permit is required from the agricultural commissioner’s office prior to use. Label rate is from 300 to 500 pounds per acre. Less than 1% of the cantaloupe and less than 0.1% of the honeydew statewide acreage were treated in 1997 with chloropicrin (1). Cost of the material and its application are considered high and thus limited acreage is treated with this material.

- **1,3-Dichloropropene** (Telone)—A preplant fumigant material applied to the soil, it is a restricted use material with a category two warning label. The application rate for vegetable crops is 12 gallons (90 lb a.i.) per acre. Approximately 4.4% of the honeydew statewide acreage was treated with this pesticide in 1997 at a rate of 76.43 lb a.i./acre. No use was reported on cantaloupe (1).

**Cultural:**
Resistant varieties are not available for nematode control. Crop rotation may be just as effective as chemical control practices. Soil solarization is another cultural control practice that can be employed to reduce nematode populations, ideally during the hottest time of the year. Most production fields would not coincide with this timing, as a field would have to be fallow during the warm summer months.

**Biological:**
No effective biological control programs have been identified for nematode control.

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**Weeds**

The most common weeds infesting melons in California are nightshade, field bindweed, nutsedge, common purslane, summer annual grasses, pigweed, and dodder. These weed species are the most prevalent in melon production and are often difficult to manage. Hand labor is usually needed for weed control in melons in California, often as part of the thinning procedure.

**Nightshades** are in the same family as potato and tomato. Weed populations can become extremely high when melons follow tomatoes in crop rotation, as most tomato herbicides are not effective against these weeds. Nightshade plants also seem to be the preferred moth egg-laying site for armyworm species. The nightshade family represents the most troublesome weeds in melon fields with regular rotation to tomato. Preplant applications of metam sodium provide good nightshade control but are not practical for early season plantings due to the 14 day waiting period from application to planting. Rimsulfuron,
recently registered as Shadeout in tomato production, is intended to provide good preemergent and postplant control but is currently not registered in melon production fields. Its use in tomato fields should reduce the buildup of nightshade weed seeds and help alleviate problems in rotational crops like melons.

**Field bindweed** is a troublesome perennial weed with a vining growth habit. Field bindweed infestations can smother melon plants and make mechanical cultivation operations difficult. None of the currently registered melon herbicides provide effective control of this weed, and thus growers must rely on cultivation and hand weeding for control. Bindweed also hosts greenhouse and iris whitefly insects, which can secrete copious amounts of honeydew, which then attracts black sooty mold. Field bindweed has a very deep taproot that helps it to survive during periods of drought and to tap into ground water. A post-harvest application of glyphosate can help manage the problem long-term in a field, but does nothing for the current crop.

**Nutsedges**, yellow and purple, are perennial weeds reproducing primarily from tubers (commonly referred to as nutlets). Nutsedge infestations are very competitive and can substantially reduce melon yields. Cultivation and hand weeding fail to provide lasting control. Registered herbicides fail to provide adequate control. Metam sodium will offer limited control of nutsedges but the tenacious weed will eventually recover and outcompete melons for nutrients and water.

**Common purslane, summer annual grasses, and pigweed** are all vigorous weeds in the warmer periods of the year. In the southern deserts, when climate modification methods are used to promote an early harvest, these weeds are aided as much as the crop is and are very competitive to the melons. Most of these weeds can be controlled with existing herbicides, but because of the growing methods used, application or soil incorporation of herbicides is difficult to impossible.

**Dodder** is a parasitic weed that attacks many broadleaf crops and weeds. It germinates in the soil and attaches to the stem of a host. Once attachment occurs, the soil connection is eliminated. Soil applied herbicides used in melons have not been effective against dodder. Control generally involves weed destruction after the melons have been harvested. Regional differences occur in weed distribution. Velvetleaf is commonly found in the Sacramento and upper San Joaquin valleys, but is not a problem in the lower San Joaquin valley. Purple nutsedge is primarily limited to the areas south of Madera County. All areas of the state have tremendous weed pressure requiring numerous weed control operations each season.

**Weed Management Practices:**

**Fall bed treatments** are often applied to melon beds in Area II in preparation for early season planting (March to early April). In this area, winter rainfall can limit the opportunity for cultural weed control and thus fall bed treatments help to maintain prepared beds free of weeds and allow melon planting
during brief early spring dry periods. In later plantings (April to July), non-selective herbicides (glyphosate or paraquat), cultivation and preplant incorporated herbicides can all be used, with rainfall occurring less frequently during this period. Expensive herbicides, such as metam sodium are generally applied as 10 to 12 inch wide band treatments, centered on the seed line, in order to reduce cost.

**IPM** practices are used in almost all melon fields. Fields are surveyed regularly for identification of escaping weeds and herbicides selected based on weeds present. Herbicide rates are also adjusted according to the species present and also to the dominant soil texture class. An example of this is trifluralin (Treflan) which has three different application rates depending on the presence of sand, silt, or clay soils. Herbicide resistant weeds have not been observed in melons.

**Alternative weed control practices** involved in melon production are usually utilized by growers. Crop rotation typically involves growing melons once every two to four years, with crops such as corn, wheat, barley, tomato, safflower, cotton, or alfalfa grown in the other years. Cultivation is used in all melons grown in California. Generally, one to five cultivation operations are used per melon crop. Subsurface drip irrigation is used in a small amount of melon production, but its use is slowly starting to increase as growers gain experience and learn to use it to its full benefit. By restricting water to the root zone of the crop, the surface remains dry, which prevents weed seed germination in the absence of rainfall. Dry surface soil also allows hand harvesting of melons at any time, which is a bonus in cantaloupe production, which commonly has many days of picking. Hand weeding is used by all melon growers in California to manage weeds that are not controlled by herbicides. The high value of a melon crop generally compensates for the expense of hand weeding, which would not be practical in lower value crops. Transplanting is occasionally used to provide a head start for the melon plants, allowing them to be more competitive with the weeds. Larger melon plants also allow tillage equipment to move more soil into the seed line to bury small weed seedlings.

As discussed previously, melon planting dates are dictated by market windows. However, within an area, planting dates can be adjusted to some degree to avoid certain weed problems. For example, early-planted melons in Areas I and II often avoid competition from barnyardgrass. Melons planted after mid-May often avoid dodder, which germinates primarily between mid-March and mid-May. Recently, several dodder resistant tomato varieties have been identified, which hold some promise of reducing the severity of this parasitic weed when melons follow tomatoes in crop rotations. Weed resistant or highly competitive melon varieties have not been developed.

Soil solarization is a non-pesticidal, soil pasteurization technique that can be used for weed and soil disease control in the melon growing areas of California. Unfortunately, it must be done in the summer, usually during the prime melon season. In addition, solarization has been shown to select for heat tolerant soil fungi, (*Phythium* spp.) that are pathogens of melons. It is also relatively expensive compared to herbicide and fungicide treatments.
Chemical Control:
Currently, the herbicides used in melon production do not limit the export of products to other countries. Herbicides used to control weeds in melons are listed below based on methods and timing of applications.

**FALL BED application before weeds emerge**

- **Oxyfluorfen (Goal 2X)**—60 days preplant restriction for application rate of 0.25 lb a.i. per acre and 90 days preplant restriction for the 0.5 lb a.i. per acre rate. 24-hour REI. This herbicide is used for preemergent and postemergent control of annual broadleaves. The rate used depends on weed size and must be considered due to the plantback restriction of 60 days minimum from treatment to planting. There is a 10-month plantback restriction for crops not on the label. In 1997, the median application rate was 0.33 lb a.i./acre for cantaloupe and 0.1 lb a.i./acre for honeydew. Approximately 1% of the cantaloupe and 7% of the honeydew statewide acreage are treated with this herbicide, in Areas I and II (1). Fall beds are not used in Area III.

**FALL BED application after weeds emerge**

- **Paraquat (Gramoxone Extra)**—Label has a 0.47-0.94 lb a.i. per acre rate, a 30-day PHI and a 12-hour REI. Paraquat is used for control of emerged annual weeds and suppressive knockdown of perennials. In 1997, the median application rate was 0.87 lb a.i./acre for both cantaloupe and honeydew (1). Most treatment is in Areas I and II. This is a nonselective herbicide which must be used with extreme caution; when applied postplant, it will kill emerged melons. Paraquat can be tank mixed with oxyfluorfen.

- **Glyphosate (Roundup)**—3 days preplant restriction. Label has a rate of 0.375-1.5 lb a.i. per acre and a 4-hour REI. Glyphosate is used for control of emerged annual weeds and as a suppressive knockdown of perennials. Results will vary depending on the size and weed species involved. In 1997, the median application rate was 1 lb a.i./acre for cantaloupe and 0.75 lb a.i./acre for honeydew. Approximately 7% of the cantaloupe acreage and 8% of the honeydew acreage are treated with glyphosate (1). Again, most of the use is in Areas I and II.

**PREPLANT and PREEMERGENCE before weeds emerge**

- **Metam sodium (Vapam)**—This material has a 14-day preplant interval between application and planting date. Rates vary with band width sprayed on beds or broadcast application based on 50 to 75 gallons (213-319.5 lb a.i.) per acre. Metam sodium is a biocide that also controls soil-borne insects, nematodes, and soil fungi. In 1997, the median application rates were 52.74 lb a.i./acre for cantaloupe and 19.34 lb a.i./acre for honeydew. Approximately 7.6% of the cantaloupe acreage and 4.3% of the honeydew acreage were treated in 1997 (1).

- **Methyl Bromide** — Very limited use for control of soil diseases and weeds prior to planting. In
Area III, used in strip fumigation or "hot-gas" for seedless watermelons, a very high value crop. In 1997, the median application rates were 135.8 lb a.i./acre for cantaloupe and 199 lb a.i./acre for honeydew. Less than 1% of the cantaloupe acreage and honeydew acreage were treated with methyl bromide in 1997 (1).

- **Bensulide** (Prefar)— Label has a rate of 5-6 lb a.i./acre and a 12-hour REI. Applied in a band over the seedline after planting at a broadcast rate of 6 quarts per acre, but before the crop is irrigated. Most use is in the southern deserts (Area III) for the control of summer weeds in early spring planted crops. The high level of crop tolerance allows use in any of the various planting methods. In 1997, the median application rates were 2.1 lb a.i./acre for cantaloupe and 2.8 lb a.i./acre for honeydew. Approximately 10% of the cantaloupe acreage and 4% of the honeydew acreage were treated in 1997 (1).

- **Ethalfluralin** (Curbit)— Label has a rate of 1.08-1.62 lb a.i./acre and a 12-hour REI. Limited use as a preemergence herbicide on spring planted melons in Area III. Cannot be used in conjunction with any plastic mulch or cover and is not effective on the "Yuma beds". Used instead of bensulide because of a better spectrum of weeds controlled, especially nightshades and groundcherry species. In 1997, the median application rates were 0.6 lb a.i./acre for both cantaloupe and honeydew. Approximately 4% of both the cantaloupe and honeydew acreage were treated in 1997 (1).

**POSTPLANT after weeds emerge**

- **Sethoxydim** (Poast)—Label has a 12-hour REI, a 14-day PHI and a 0.28 lb a.i. per acre rate can be applied up to two times per season for control of annual and perennial grasses. Crop oil concentrate at 1 quart per acre needs to be used with the herbicide. This herbicide is selective on grasses and can be generally applied without fear of crop injury. In 1997, the median application rates were 0.08 lb a.i./acre for cantaloupe and 0.12 lb a.i./acre for honeydew. Approximately 3.6% of the cantaloupe acreage and 2.4% of the honeydew acreage were treated in 1997 (1).

**LAYBY before weeds emerge**

- **Trifluralin** (Treflan, Trilin)—Label has a 0.5-1.0 lb a.i./acre rate, a 30-day PHI and a 12-hour REI. Rate is dependent upon soil type with the lower rate used on coarse, sandy soils. This herbicide is applied as a directed spray to the soil between rows or as a shielded spray to avoid spraying over the tops of plants. Some yield loss could be expected from plants sprayed with the material. The herbicide must be incorporated into the top several inches of soil. It is used for control of annual grasses and broadleaves. Treatment was mostly in Areas I and II. Not much is used in Area III, because the time from layby to harvest is short and the weed problem not too severe. In 1997, the median application rates were 0.72 lb a.i./acre for cantaloupe and 0.6 lb a.i./acre for honeydew. Approximately 19% of the cantaloupe acreage and 10% of the honeydew acreage were treated in 1997 (1).
- **Ethalfluralin** (Curbit)— Label has a rate of 1.08-1.62 lb a.i./acre and a 12-hour REI. Applied as a directed spray to avoid contact with the tips of melon runners at layby. Material needs to be incorporated into the soil within a few hours of application. This is usually done with a lilliston with rolling sectioned spider cultivators. Ethalfluralin is used to control annual grasses and broadleaf weeds along with nightshades. In 1997, the median application rates were 0.56 lb a.i./acre for both cantaloupe and honeydew. Approximately 4% of both the cantaloupe and honeydew acreage were treated in 1997 (1).

- **DCPA** (Dacthal)— Label has a rate of 4.5-10.5 lb a.i./acre as a directed spray to avoid contact with the tips of melon runners at layby. Limited use in melon production, this has always been very expensive compared to trifluralin with about the same spectrum of weed control. Dacthal has a category 3 - caution label. Dacthal should be applied when melon plants have 4 to 5 true leaves. In 1997, the median application rate was 6 lb a.i./acre for cantaloupe and 3.75 lb a.i./acre for honeydew. Approximately 1% of the cantaloupe acreage and 0.01% of the honeydew acreage were treated in 1997 (1).

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**Vertebrate Pests**

**Horned Larks, *Eremophila alpestris***

Horned larks are one of the most notorious bird species that are known to reduce plant stands. Direct seeded melon fields are susceptible to horned lark damage from seedling emergence until the plants reach approximately three true leaves stage. It takes a trained eye to detect horned larks in the field. They commonly fly very low to the ground and their natural color pattern blends in very well with the soil and open ground. They can reduce plant stand by pulling up seedlings as they walk up the planted row during feeding. Horned larks can usually be found in small flocks of about 20 birds in all agricultural production areas of California. Large bare spots in the plant stand can be quickly produced by small flocks of horned larks.

**Control:**
The only effective control strategy to reduce horned lark damage to seedlings is to try and protect the crop by a constant patrol of the field with movement and noise acting as a deterrent to feeding. Horned larks are notorious for being bold birds that do not scare easily and fly away only when a person gets within 15 to 20 feet. Once they have established a feeding pattern, horned larks will not be scared away with noisemakers such as propane cannons or even shooting. If they do fly off, it may be only for a short distance.
The use of Mylar tape strips attached to solid set sprinkler pipes or risers in the field has had very limited success. Horned larks are classified as migratory birds under federal law and any lethal control attempts must be cleared through the local county agricultural commissioner’s office. Growers who need to thin a melon field should delay thinning activities until plants achieve three true leaves.

**Rabbits**

Fields that border almonds or ditch banks may receive crop damage from rabbits chewing on melon fruit or plant material. Bait stations with diphacinone have been effective in controlling the pest. Vertebrate pest control efforts should be cleared through the county commissioner's office.

**Voles, Microtus spp**

Voles, or sometimes referred to as meadow or field mice, can be a minor pest in melon fields. Pest control advisers report a higher occurrence of voles when melon fields are located next to alfalfa hay fields. This would imply a migration along field borders once crop development has progressed enough to provide cover for the pest. Voles feeding in a field can damage melon plants and small fruit. Voles are active during the night as well as daytime with year-round activity being common.

**Control:**
Prevention appears to be the best management strategy. It may be necessary to remove or destroy suitable plant material that voles may be inhabiting along field borders. The situation may require the placement of poison baits.

Field monitoring along field borders, ditchbanks, and fencerows would lead to a better understanding of any potential vole population. Glue boards have been used along vole runways and entrances to burrows to aid in determining the pest populations so that effective control actions are implemented.

**Chemical:**
There are no registered poison baits for use within a melon field once a crop has been planted. Poison baits would need to be in place early in the season prior to planting or even in late winter before the rodent-breeding season. Baiting during winter months has proven to be effective as acceptable forage material is far less abundant compared to plant growth in the spring. Once the spring breeding season starts, the numbers of voles may quickly rise to the point where effective baiting is inadequate to reduce pest numbers. Baiting is usually performed with an anticoagulant poison, such as diphacinone, which requires multiple feedings. Bait needs to be close to the runways and burrow entrances to be effective.

**Cultural:**
Pest exclusion would be dependent on keeping the voles out of the field by managing the habitat they live in or by physically providing a barrier that prevents entry into the field, such as a small irrigation ditch containing water alongside the field. Fencing the field perimeter is not practical. Traps may be able to reduce small populations but would require time and personnel to service them. Traps are effective when using an attractant such as peanut butter mixed with oats.

**Biological:**
Several bird species such as owls and hawks are predators on voles. Owls can be encouraged to stay in an area if adequate nesting sites are provided. Voles will not explore new areas unless adequate cover is present to protect them from bird predation.

**Gophers**
Field Borders should be monitored to check for gopher activity as this is where most gopher damage occurs in melon fields. Special tractor driven field implements can be used to create artificial gopher tunnels for use with strychnine or anti-coagulant baits prior to planting. Vertebrate pest control efforts should be cleared through the county commissioner's office.

**Ground Squirrels**
Fields that border almonds may receive crop damage from ground squirrels chewing on melon fruit or plant material. Bait stations with diphacinone or chlorophacinone have been effective in controlling the pest. Vertebrate pest control efforts should be cleared through the county commissioner's office.

**Crows**
Crows are classified as migratory birds under federal law in the United States and any lethal control attempts must be cleared through the local county agricultural commissioner's office. Crows damage melons in the harvest ready stage as the birds peck into the fruit in attempts to get the seed. Once a single puncture has been made into the flesh, the melon is unfit for harvest and is culled from the pack out. Once they have established a feeding pattern, crows will not be scared away with noisemakers such as propane cannons or even shooting. If they do fly off, it may be only for a short distance.

**Current Research and Topics of Concern**
Six different moth species are being monitored in pheromone traps as part of a research project funded by the California Melon Research Board in Fresno, San Joaquin, Merced, and Sacramento Counties. Trap data is collected and disseminated in a cross commodity program whereby trap data is being shared with the Fresh Market Tomato industry. Cabbage looper, western yellow striped and beet armyworms, black and variegated cutworms, and corn earworms are being trapped in a network of over 80 pheromone traps set up across the San Joaquin Valley. The short-term intention of the project is to monitor male moth flight activity and identify regional moth flights to alert PCAs and field personnel when a potential pest problem has been detected so that more intensive field monitoring activities can be implemented. The long-term intention of the project is to collect regional data to be used in insect degree-day model validation.

The material Spinosad (Success), is expected to get cucurbit labeling in the near future as it cleared registration in 1998 for tomato and broccoli crops in California. Application patterns have yet to be established in other crops and early reports were variable as can be expected from a product that has had little commercial development time. The product is highly toxic to bees and its use in melon fields would have to be carefully controlled during pollination periods when honeybees are actively foraging.

It has been suggested that the use of imidacloprid (Admire 2F) for systemic control of aphids has apparently reduced the threat of crop losses from CABYV. This virus has a persistent transmission by aphids feeding for about 10 hours. The virus has not been seen in melon production in the last several years but was implicated as the cause of severe crop losses of cantaloupes in the past.

AQ10 biofungicide is a new product offering control as a naturally occurring parasite, *Ampelomyces quisqualis*, of powdery mildew that can be rotated with other materials such as sulfur. It has a 0 day PHI and a 12 hour field reentry. There is limited field experience due to its recent entry into the market. It was used on 1.3% of the honeydew acreage in 1997 (1).

Azoxystrobin (Quadris) may offer some control of powdery mildew. Expectations for a new federal labeling on melons would have to be followed by a state label registration prior to use in California. This material was recently registered for use on powdery mildew in tomatoes grown in California. Initial grower experience in tomatoes, indicates control poorer than myclobutanil (Rally - Section 18 for melons, renewed in 1998 and 1999).

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Numerous growers, packers and shippers, and Pest Control Advisers, active in the cantaloupe and
honeydew melon industries, willingly provided valuable information on current practices and alternatives in pest control.

References

3. California Department of Food and Agriculture. [http://www.cdfa.ca.gov/pests/updates/](http://www.cdfa.ca.gov/pests/updates/)
15. Personal communication with Scott Adams, Biological Consultant on 10-14-99.

Appendices

1998 Melon Acreage and Production Data
1998 SEASON
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<td>100.00%</td>
<td>57,150, 33,630,337</td>
<td>6,197, 4,832,477</td>
<td>7,561, 4,867,478</td>
<td>70,908</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All production numbers are in carton equivalents as follows:

Cantaloupe – 40 lb  
Honeydew – 29 lb  
Mixed – 33 lb (except for Imperial County which used a 40 lb carton equivalent)  
When honeydews were combined with the "mixed" category, a 33 lb equivalent was used.
Database and web development by the NSF Center for Integrated Pest Management located at North Carolina State University. All materials may be used freely with credit to the USDA.