Pest Management Strategic Plan

Cantaloupe, Honeydew, and Mixed Melon Production in California

Prepared for the
United States Department of Agriculture and the
Environmental Protection Agency

By the

California Melon Research Advisory Board

and the

California Minor Crops Council

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Executive Summary

The new safety standards set forth by the Food Quality Protection Act (FQPA), under review by the Environmental Protection Agency (EPA), will impact the use of certain crop protection tools used by the agricultural community. In order to facilitate this transition to "Reduced Risk" pest management, the United States Department of Agriculture (USDA) has requested that all commodity groups develop a "Pest Management Strategic Plan" (PMSP) to identify the critical research, registration, and educational needs for their specific commodity. "Reduced Risk" is a very broad term used to describe pest management techniques and tools that have low inherent toxicities and those that have a minimal impact on the environment.

For California melon growers in particular, the label registrations of Diazinon and Dimethoate are examples of products that are being modified, cancelled, or restricted due to FQPA. Due to the possible loss of these or other valuable crop protection tools, coupled with widespread reductions in funding and Land Grant University personnel to conduct field research and extension programs, it is imperative that all resources be used in the most efficient manner possible. The objective of this strategic plan is to develop a comprehensive list of critical concerns of the cantaloupe, honeydew, and mixed melon industries in California and to recommend means to address these priorities with the most appropriate resources in the areas of research, registration, and education.

This strategic plan includes an overview of melon production, cultural practices, seasonal pest occurrences, and management techniques throughout the state. Both current and emerging pest management needs are addressed in this plan. Efficacy ratings of various pest control techniques (chemical and non-chemical) used in melon production have been summarized from input made by growers, Pest Control Advisers (PCAs), researchers, and other experts involved in field activities. As a result of the original PMSP meeting held on January 7-8, 2002, several critical areas have been identified by the melon industry. In addition, a follow-up meeting of the pest management review team from industry provided valuable input at their meeting on January 6, 2003. The following priority areas, listed in order of importance, must be addressed in order to maintain the long-term viability of this industry.

Research Priorities*:* Finding practical solutions to insect control are of immediate and serious concern to producers of melons in California.

1) Of significant importance is the need to find effective alternatives to rotate with Diazinon, a highly efficacious organophosphate insecticide used for leafhopper and soil-borne pest control. This material, along with other chemicals in this class of chemistry, has received intense scrutiny and is under threat to be removed or have the label modified as a crop protection tool.
2) Pre-emergence and also post emergence control techniques and products are needed for the following broadleaf weed species: black nightshade, field bindweed, yellow nutsedge, common purslane, and pigweed.

3) Soil-borne disease research is needed that includes pathogen biology and control strategies for *Macrophomina, Phytophthora, Pythium,* and races of *Verticillium* and *Fusarium* that are found in California and for *Monosporascus cannonballus* and any other pathogen associated with vine decline.
4) Development of resistant varieties for the mosaic virus complex needs to be encouraged, advanced, and incorporated into existing seed development research. Plant breeding research should find and develop new melon varieties that are resistant to the many plant diseases and insect pests that are problems for the grower.
5) Development of resistant varieties for the races of *Verticillium* and *Fusarium* that are found in California and that impact on melon production is encouraged.
6) Virus biology research is needed for all viruses that can inflict losses in melon production such as Poly viruses and gemini viruses. The understanding of the basic biology of disease/vector relationships is critical to the industry, especially for learning how to avoid and reduce losses from viruses.
7) Melon growers are concerned about effective control of soil pests that damage melons at harvest time, such as earwigs, pinworms, and cutworms. Alternatives with very low pre-harvest intervals need to be developed to rotate with organophosphates and carbamates.
8) Evaluate the use of manure in terms of potential food safety issues.

Regulatory Priorities: The most important regulatory action that needs to be done involves an enhanced interaction between Cal-EPA and US-EPA.

1) Harmonization between Cal-EPA and US-EPA should be encouraged to facilitate and hasten the registration of reduced risk products. It now appears that concurrent registrations of pesticide labels on a federal and state level have been lost. Budget cuts at the state level at the California Department of Pesticide Regulation (CDPR) would force a longer waiting period for state reviews. Any delay in getting the federal pesticide label approved for use in California puts our growers at a disadvantage when materials get approved first in other states. The registration process for new chemicals should be looked upon as a means to add alternatives for use in rotation with older products that need to be retained for pesticide resistance management.

In terms of specific registrations, the melon industry also needs:
2) New products to rotate in an insect pest resistance program with Diazinon for leafhopper control and soil pests that impact on stand establishment and also at harvest time.
3) New chemistries for powdery mildew control and overall disease resistance management.
4) Language on pesticide labels needs to consistent and easily interpreted for the various melon types.
5) Determine the status of IR-4 projects in regard to melons.
6) Identify any Codex International issues regarding products used on melons that go into the export market.

Educational Priorities: The melon industry has been very proactive in providing educational opportunities for growers and PCAs with considerable cooperation from personnel with the University of California (UC) and also USDA researchers. In addition, the California Melon Research Board (CMRB) has been involved with the Pesticide Environmental Stewardship Program (PESP) at the federal level to identify strategies for reduced risk. Specific targets for new educational opportunities are:

1) Educate government agencies on unfair trade/cultural practices, which result from regulatory burdens.
2) Regulators and consumer groups must be educated as to how Integrated Pest Management (IPM) practices are used in melon production and how this system optimizes food production while it minimizes risks to workers and the environment. This is especially important as it relates to risk assessments for crop production.
3) The general public needs to understand how IPM is used in agriculture and how changes brought about by the FQPA review impacts on the cost of food. The economic side of replacing low-cost pesticides with newer, but much more expensive, materials needs to be considered in the review process.
4) Resistance management to preserve both new and old pesticide chemistries.
5) Training and demonstration of alternatives to methyl bromide for soil-borne diseases.
6) Technology transfer on how to use new chemistries with economic thresholds.
7) Outreach efforts need to be expanded to small-scale melon growers.
8) Use of degree day and crop models for both pest control and plant growth analysis.
9) Finally, the public should be reminded through effective media (e.g., “Buy California”, “Five a Day” programs) that the consumption of fresh fruits and vegetables, particularly melons, contributes to a nutritious diet and healthy lifestyle.

The industry has also appreciated efforts made by numerous individuals on field days with EPA, CDPR, and USDA representatives to discuss and highlight areas of concern and identify educational opportunities at both federal and state levels.

It is hoped that this strategic plan will serve as a resource for those wanting to learn more about the production of melons in California and especially those issues associated with pest management. A comprehensive list of growers, PCAs, industry representatives, and UC research and extension personnel is provided to identify individuals with expertise in particular areas.

This PMSP has been prepared with an immediate time frame of three to five years. The melon industry will periodically review, adjust, and update priorities to remain current with industry developments and issues. The California cantaloupe, honeydew, and mixed melon industries appreciate the support and assistance of EPA, USDA, CPDR, and the UC Land Grant system as we seek to find solutions for issues and concerns facing this important industry.

For the sake of all readers, the reference to a pesticide name identified in the body of this report will be shown in both the approved common name and the registered trade name. The American National Standards Institute and the International Standards Organization have approved of common names of pesticides. Please see the Glossary of Pesticide Chemicals listed in the reference section of this report for the latest glossary version (13). Since this is an industry document, all references will identify the chemical in the registered trade name as growers and PCAs are more familiar with the registered trade name. In addition, the scientific name will be identified in the first reference of a specific pest with just the common pest name used for subsequent listings.

Major funding for this project was accomplished through grants to the California Minor Crops Council from the EPA Region 9 Agricultural Initiative and the USDA Cooperative States Research, Education, and Extension Service (CSREES) “Pest Management Alternatives Program (PMAP)” programs.

Additional support was provided through the CMRB, the California Cantaloupe Advisory Board, the California Pest Management Center at UC Davis, EDEN Bioscience Corporation, Bayer CropScience, DuPont Ag Products, and FMC Corporation.

We are extremely grateful for the contributions of all of these organizations and their active participation in this process.

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California Melon Research Advisory Board California Minor Crops Council

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The mention of any specific product in this document does not represent endorsement by any member or organization within the California Melon Work Group.

California Production Facts

Melons belong to the cucurbit family of plants, known as Cucurbitaceae, which includes cucumbers, gourds, squash, and pumpkins. There are several different genus names used in the family. Cantaloupes (*Cucumis melo* L. var. *cantalupensis*) (7) and honeydews (*Cucumis melo* L. var. *inodorus*) (18) are classified in the same genus. Mixed melons include crenshaw, casaba, Santa Claus, Persian, Juan Canary, piel de sapo, and other melon types. Melons that are commonly cultivated are divided into several groups. The Reticulatus Group, or netted melons, includes cantaloupes, Persian melons, and muskmelons. The Inodorus Group, or winter melons, includes casaba, crenshaw, and honeydew melons. Melons are grown on flat beds with a typical width of 80 inches. Melons are warm-season annuals that are very sensitive to frost.

State reporting systems for pesticide use and also production statistics may vary according to melon type and may include cantaloupes and honeydews in the same category (21). Statistics for the year 2000 from the County Agricultural Commissioner's offices are shown in the appendix (8).

Cantaloupes

- California ranks first in the nation in production of cantaloupes. Acreage plantings for the year 2000 from the USDA National Agricultural Statistics Summary show California ranked number one with 58,500 acres of the total 102,430 planted acres in the United States. This puts the state's production at approximately 57% of all cantaloupes grown in the US (26). Harvested acreage was 57,500 acres.

- Total production of cantaloupes grown in the US in 2000 was 20,292,000 hundred weight (cwt.) with an average US yield per acre of 207 cwt. (26). This would equate to 517.5 cartons per acre using a 40 pound box. The average yield of cantaloupes in California was 220 cwt., which would equate to an average yield of 550 cartons per acre (22). The harvested acreage total of 57,500 multiplied by the average yield of 220 cwt in California would give a figure of 12,650,000 cwt, which is approximately 62% of the total US yield. Cantaloupe growers in California would identify an excellent yield as 800 cartons per acre.

- In 2000, cantaloupes ranked 35th in gross value among all California agricultural commodities with a total of $156,590,000 (22). Based on data from the offices of the County Agricultural Commissioners in California, the average value per harvested acre was $2,694.

- Cantaloupes grown in California are shipped throughout the US market as shipments to Canada have declined in recent years due to the large difference in exchange rates for the dollar. The need for refrigeration (38 degrees F) after harvest has prevented growers from shipping cantaloupes overseas (19).

- Data from the CMRB indicates that cantaloupes accounted for 77% of the total 14.8 million hundred weight for the state's melon crop in 2000 (6).

Honeydews

- California also ranks first in the nation in production of honeydew melons. The same 2000 summary shows California ranked number one in planted honeydew acreage at 22,000 acres of the total 28,600 planted acres in the US (26). This puts the state's production at approximately 77% of all honeydews grown in the US (26). Harvested acreage was also 22,000 acres.

- Total production of honeydews grown in the US in 2000 was 5,572,000 hundred weight (cwt.) with an average US yield per acre of 196 cwt. This would equate to 653 cartons per acre using a 30-pound box (22). The average yield of honeydews in California was 190 cwt., which would equate to an average yield of 633 cartons per acre. Honeydew growers in California would identify an excellent yield as 1,000 cartons per acre.

- In 2000, honeydew melons ranked 59th in gross value with a total of $45,172,000.

- Based on data from the offices of the County Agricultural Commissioners in California, the average value per harvested acre was $2,709 (22).

- Data from the CMRB indicates that honeydews accounted for 20% of the total 14.8 million hundred weight for the state's melon crop in 2000 (6).

Mixed Melons

- Mixed melons include numerous different types with Juan Canary, Persian, casaba, crenshaw, Santa Claus, and piel de sapo being the most common (18). Specific production data on each mixed melon type is not available. The estimate on crop acreage of mixed melons is approximately 8% of the state's total melon acreage (21).

- Data collected by the CMRB indicates that mixed melons accounted for 3% of the total melon crop in the state as identified by total hundred weight (6). Mixed melon production has been relatively constant in the state as 6 out of 7 years from 1994 to 2000 showed mixed melons with 3% of the total melon crop.

- In 2000, mixed melons accounted for a total crop value of $16,263,000 in the state.

This strategic plan reports on production of cantaloupes, honeydews, and mixed melons grown in California. No information on watermelons is included. Production statistics for the main melon types can be found in the appendix.

Production Regions

There are three commonly recognized areas of melon production in California (9). These areas can be seen on the state map shown in Figure 1 on page 10.

Area I, located in the northern San Joaquin Valley and lower Sacramento Valley grows approximately 6% of the state's cantaloupes with production focused in Stanislaus County (8,11). Area I produces 56% of the honeydews with production in Sutter, Yolo, and Stanislaus Counties. Counties are being listed in order of highest planted acreage (6). Area I also produces approximately 21% of the mixed melons in Stanislaus and San Joaquin Counties. Planting of melons is from April to early July with harvest from mid-July to mid-October. Rainfall varies from about 26 inches per year in the Sacramento Valley to about 16 inches per year in Modesto in the northern San Joaquin Valley (4). Area I uses flood irrigation to pre-irrigate melon fields then utilizes dryland-farming techniques to force the melon plants to send their root systems downward to a high water table. This allows melon growers to avoid subsequent irrigations via furrows.

Area II, the southern San Joaquin Valley, produces about 66% of the cantaloupes grown in the state (8,11). Production of cantaloupes occurs in Fresno, Merced, Kern, and Kings Counties (6). Area II produces 24% of the honeydews with production centered in Fresno County. Area II also produces 53% of the mixed melons in Fresno, Merced, and Kern Counties. Melons are planted from mid-March to mid-July with a harvest period from late-June into mid-to-late October depending on weather. Fresno receives about 10 inches of rainfall per year while Kern County receives about three inches per year (4). Furrow irrigation is very common in Area II, though there are some growers using subsurface drip irrigation in all three melon types. The growing region in Area II is commonly referred to as the westside district for melons as production occurs along the western part of the valley.

Area III, the desert growing region, covers Coachella, Imperial, and Palo Verde Valleys. Area III has both a spring and a fall crop of cantaloupes and honeydews. Planted acreage of cantaloupes and honeydews in Area III is split with about 76% of the acreage in a spring planting and the balance of 24% in a fall crop (18) . This region grows about 28% of the state's cantaloupes with production across Imperial and Riverside Counties (7). Area III also produces 20% of the honeydews in the same counties. Area III produces 26% of the mixed melons with most of the production in Riverside County and minor acreage in San Bernardino County. Spring planting starts in mid-December and goes through March with harvests from mid-May into mid-July. Fall melon planting occurs in July and August with a fall harvest period from October into late December (7,9,18). This area produces melons with less than four inches of rainfall per year (4). Furrow irrigation is commonly used though there may occasionally be drip. Area III will be identified as Desert Valleys in tables.

Melon Crop Phenology

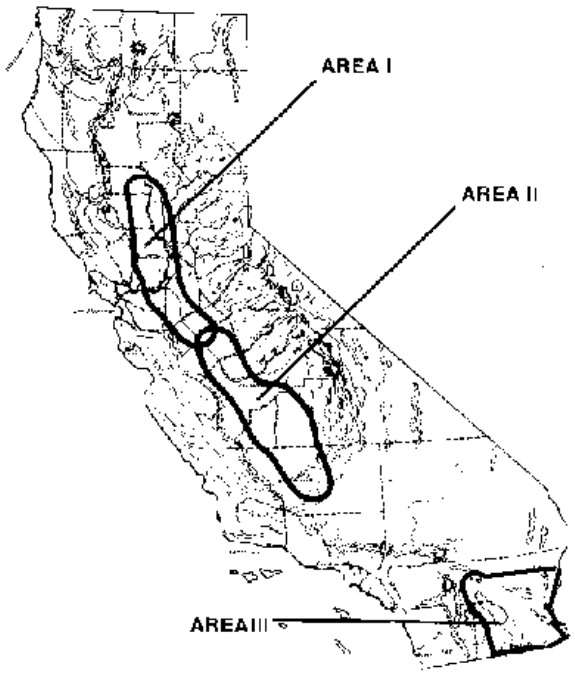
Table 1 shows the typical cantaloupe crop phenology events, shown in days, involved from planting to bloom to fruit development to harvest for the main production regions. Honeydews and mixed melons would be expected to take several days longer in the development period compared to cantaloupes. Melons have optimal germination when the soil temperature is at least 60 degrees Fahrenheit. The longest germination period would occur in early spring when melon seed is planted into cool, wet soils. Melons can

germinate in three days if seeds are planted into warm soils during the summer month of July. Hybrid seed varieties have been known to develop faster and with more plant vigor compared to open-pollinated varieties. This phenomenon is commonly referred to as hybrid vigor and technically it is referred to as heterosis (11). This means that progeny that results from genetically different parent lines have an increase in vigor compared to the average parent lines.

Table 1. Melon Crop Phenology in Days

Desert Valleys	Planting to Emergence	Emergence to Bloom	Pollination	Fruit Development	Harvest Period
Average	7	30	60	30	8
Expected Range	5-10	21-35	50-70	30-40	6-10
Sacramento & San Joaquin Valleys					
Average	7	30	30	30	10
Expected Range	5-10	21-35	30-35	30-40	7-14

Figure 1. Melon Production Regions in California



Foundation for a Pest Management Strategic Plan

Members of the California melon industry representing researchers, growers, packers, shippers, commodity groups, and PCAs, were asked to join a work group with invited

representatives from the USDA, EPA, and the California Pest Management Center. The goal was to lay a foundation for the development of a strategic plan for pest control problems of significant concern to California melon growers and handlers. Their input provided an important viewpoint to the pesticides and alternatives used and to the diversity of IPM practices for the major melon growing regions of the state. Members of the California Melon Work Group and their affiliations are identified with contact information provided at the end of this document.

In order to evaluate pest management strategies, a review of pesticides that were the most commonly used materials in California melons in 2000 was made by searching the CDPR database on pesticide usage (21). These materials are listed on the next page in Tables 2 and 3. Not all materials would necessarily be used on a single crop. Pesticides are ranked based on total acreage treated with the highest amount listed first. It should be noted that the term pesticide is a general term that includes insecticides, fungicides, herbicides and other materials used for pest control. The most commonly used insecticides, fungicides, and herbicides are identified with additional information found in the appendix.

Table 2. Most Common Pesticides Used in Cantaloupes, 2000.

Insecticides	Fungicides	Herbicides
Imidacloprid (Admire) Methomyl (Lannate) *Bt (Bacillus thuringiensis)* Avermectin (AgriMek) Endosulfan (Thiodan) Diazinon (Diazinon) Carbaryl (Sevin)	Sulfur Mefenoxam (Ridomil Gold) Trifloxystrobin (Flint) Benomyl (Benlate) Thiophanate-methyl (Topsin) Seed treatment- Thiram (12)	Trifluralin (Treflan) Bensulide (Prefar) Glyphosate (Roundup) Oxyfluorfen (Goal) Sethoxydim (Poast)

Table 3. Most Common Pesticides Used in Honeydews, 2000.

Insecticides	Fungicides	Herbicides
Bifenthrin (Capture) Methomyl (Lannate) Carbaryl (Sevin) Diazinon (Diazinon) Esfenvalerate (Asana) Imidacloprid (Admire) *Bt (Bacillus thuringiensis)*	Sulfur Trifloxystrobin (Flint) Mefenoxam (Ridomil Gold) Thiophanate-methyl (Topsin) Benomyl (Benlate) Azoxystrobin (Quadris) Seed treatment- Thiram (12)	Trifluralin (Treflan) Glyphosate (Roundup) Oxyfluorfen (Goal) Bensulide (Prefar) Ethalfluralin (Curbit)

Source for Tables 2-3: California Department of Pesticide Regulation, 2000 Annual Pesticide Use Report Data Indexed by Commodity (21).

Pesticides used in honeydew production would be very similar to those used in mixed melon production.

Insecticides are used on 76% of all cantaloupes grown in California compared to 74% of the total US melon crop (1). Insecticides are used on 78% of all honeydews grown in California compared to 80% of the total US honeydews crop (1). Most treatments are applied to the melon foliage after crop emergence with sprays made to protect the crop after fruit has set. The primary pests to all melon types targeted by these foliar treatments include aphids, whiteflies, cabbage loopers, and leafminers (7,18). The primary soil-borne pests targeted by insecticide treatments prior to, and at planting, include wireworms, seedcorn maggots, darkling ground beetles, cutworms, and flea beetles (9, 24). Please see Tables 11,13, 18, 19, 26, and 27 for specific information on the most important insecticides used in melon production in California.

Fungicides were used on 52% of the cantaloupes grown in California in 2000 compared to 60% of the total US cantaloupe crop (1). Fungicides were used on 10% of the honeydews grown in California in 2000 compared to 26% of the total US honeydew crop (1). Most fungicide applications are made by foliar treatments. The major disease organism targeted by these treatments is powdery mildew (7, 18). Please see Tables 14, 22, 23, 30, and 31 for specific information on the most important fungicides used in melon production in California.

Herbicides are used for weed control on 42% of the cantaloupes grown in California compared to 43% of the total US crop (1). Herbicides are used for weed control on just 3% of the honeydews grown in California compared to 12% of the total US crop (1). A postplant herbicide application of Trifluralin (Treflan) is made at layby by some growers across the 80-inch bed except the 10-inch band centered on the seed line (11). Layby is considered the last stage of melon growth when cultivation equipment can still be used as melons would be in bloom with runners advancing across the bed. This preemergent herbicide is applied to the area outside the seed line to control late emerging weeds. After layby, there would be no herbicide applications until after the crop was harvested.

The remainder of this document is an analysis of agronomic practices, pests, and pest management tools used during the major stages of the melon production season. In some cases, certain sections will be divided by area or season to describe regional differences. Time lines of seasonal pest occurrence, pest management field activities, and cultural practices for each production area are provided in the Appendix. A comprehensive overview of melon production practices, pests, and control techniques, have been previously identified in the Crop Profile for Melons in California (9). Please see Tables 16, 20, 21, 28, and 29 for specific information on the most important herbicides used in melon production in California.

The critical issues and concerns of the melon industry in California have been presented in this strategic plan according to the time during the production season in which they occur, e.g., early season, fruiting, etc. A “To Do” list has been developed for each issue raised by the working group. In order for the industry to address these topics in the most systematic manner possible, the issues have been listed according to whether they fall into the categories of research, regulatory, or educational needs.

Land Preparation to Planting Period

Land preparation is the first step before planting melons. Almost all melons are planted on raised beds in California to facilitate subsequent cultivation and irrigation of the

melon crop, as well as to improve drainage, which minimizes root diseases (9). Land preparation consists of several discing operations, chiseling to break up hardpan layers at the bottom of the disc zone, and sub-soiling with heavy machinery such as caterpillars to break up deep compacted layers. The number of discing and chiseling passes needed to prepare a field for melons usually depends on the preceding crop. Triplane leveling, sometimes in two passes across the field, would be used for proper grading for furrow irrigation. Melon beds are most often 80-inches wide (7). Growers in Area II would make sure that the furrows were deep enough for irrigation while growers in Area I would make very shallow rows as they don't need deep irrigations due to the low water table. Growers in Area III utilize a modified bed called a Yuma bed to capture more solar radiation in south-sloped beds in early spring in the desert region. This type of bed allows for more heat penetration and absorption of energy (7). After seedling emergence, Yuma beds would then be reshaped to a more traditional flat bed. Yuma beds are not used for the fall plantings in Area III.

Most melons are planted from seed with minimal use of transplants. Most fields are direct seeded with hybrid seed with precision air planters to insure a good stand. Some growers still use open-pollinated seed varieties but their use has been greatly reduced in recent years. Most melon fields would then be thinned by hand crews several weeks after seedling emergence.

Irrigation is used for all California melons and may be through furrow, sprinkler, or drip systems. Furrow irrigation is commonly used in melons grown in the San Joaquin Valley and proper grading is critical for good drainage and for reducing disease levels. Drip irrigation is used in the Coachella Valley in the desert region in both the spring and fall plantings. Furrow irrigation is used in the spring plantings in the Imperial and Palo Verde Valleys while drip systems are used in fall plantings. Sprinkler irrigation can be used to germinate a direct seeded crop, but this type of system is rarely used after fruit set, as the use of sprinklers may increase fruit diseases. Drip irrigation is used on about 20% of the melons grown in California as it provides for good water management and allows hand harvesting at regular intervals. Subsurface drip irrigation is used in some areas; especially where salt buildup in the soil is a problem.

Weed control as a part of bed preparation is done in the fall in most growing areas. However, the methods of weed control used will depend upon the type of irrigation system used (15). Fallow bed herbicide treatments are sometimes used to prevent winter weed growth and to allow for melon planting in early spring. Weed pressure is a concern for growers who use pre-shaped beds. Growers who plant melons after wheat or barley harvest in the San Joaquin Valley would make melon beds just prior to pre-irrigation and planting and would avoid many winter weed problems encountered with pre-shaped beds. Weed management is a key component of melon production in California. Practices may be done "in season" and/or "out of season" and the techniques used vary according to predominant weed species, location, irrigation systems, and cost. Weed control may be done with herbicides, cultivation, hoeing, or flaming. The various timings are classified as follows:

- Fall bed treatments – done before weeds emerge and crop is planted
- Fall bed treatments – done after weeds emerge but prior to planting
- Preplant – done before weeds emerge, but shortly before crop is planted
- Layby – after crop is planted but before weeds emerge
- Postplant – after crop is planted and after weeds have emerged

Soil fumigation with methyl bromide was used on 645 acres of cantaloupes in California in 2000 (21). The database didn't show any use of methyl bromide on honeydews or other mixed melons. Another fumigant that may be used after bed preparation but prior to planting would be methylcarbamodithioic acid (metam-sodium or Vapam) which would be applied to the seed line under a cap of soil. Chloropicrin or 1,3-dichloro-propene (Telone) can also be utilized after bed preparation but prior to planting.

Early Season Pests – Direct Seeding to Emergence and Stand Establishment

Major Insect Pests of Early Season Melons

Pest Control Advisers monitor early season insect pests by examining plants, nearby soil, and associated soil clods shortly after fields are planted or sometimes transplanted. Adjacent fields and vegetation are usually also checked to see if there are pest species migrating into melon fields. Early season pests are a problem during seed germination and seedling emergence and can significantly reduce plant populations and stand establishment. Chemical controls for these insects include organophosphate and carbamate baits and pyrethroids. Additional information on specific insect and mite pests mentioned in the text can be referenced in Tables 9-12 in the appendix.

Variegated Cutworms (*Peridroma saucia*) and Black Cutworms (*Agrotis apsilon*) are the most common cutworm species found in California melon fields (9,24). Cutworms are serious insect pests of emerging and young melon plants. They are generally night feeders and chew through stems at or near the soil line, reducing the stand. Cutworms are effectively controlled using carbaryl (Sevin) bait with most applications made by ground rigs to a small-banded area of about 8-10 inches of the melon beds. Growers in the Sacramento Valley make band applications of Sevin bait on at least 98% of the acreage treated with bait. The Central Valley is usually planted into pre-irrigated soils and ground rigs may not be able to enter fields. When that happens, aerial applications of bait would be necessary. Permethrin (Pounce) and esfenvalerate (Asana) provide fair to good control of cutworms. However, these pyrethroids are used judiciously as overuse may cause leafminers or thrips populations to flare up later in the season. Pyrethroids offer a broad-spectrum control that is a definite plus for pest control in the desert region because soils there don't hold adequate moisture for typical planting and capping operations. Sanitation is a key cultural control practice used to reduce these pests as cutworms are harbored in vegetative trash and weeds. Therefore, cutworm infestations can be avoided by not planting into fields with large amounts of plant residues. Certain crop rotations can also be avoided to stay away from grass crops or pastures that promote cutworm populations. Natural biological control occurs after cultivation as birds eat the exposed larvae in the soil. Cutworms can be a problem in late-planted melon fields grown after barley or wheat crops have been harvested in early June in the San Joaquin Valley. Burning of grain stubble is effective in controlling grasses and cutworms too, but there are air quality issues associated with this practice. Efficacy data is needed to verify if the botanical pyrethroid, Pyganic, offers adequate pest control in organic fields.

Darkling Ground Beetles (*Blapstinus spp*. and others) also feed on young plants near the soil line and usually are most prevalent at the edges of weedy or fallow fields. Darkling beetles can be effectively controlled with Sevin bait or Diazinon granular

applications (9). These beetles can eliminate entire fields if not controlled as large numbers of the pest move around fields in early spring.

Flea Beetles (*Epitrix hirtipennis*) chew holes in leaves and stems, weakening the tender plants. Flea beetles are also effectively controlled with Sevin applications. Esfenvalerate (Asana XL) is effective when run through a solid-set sprinkler system, although this is not a common practice. Foliar applications of methomyl (Lannate) or oxamyl (Vydate) provide good control of flea beetles, which typically have a very short window of being a pest in melons.

Seedcorn Maggots (*Delia platura*) are usually considered early season pests from March through May. Lindane (Isotox Seed Treater F) used to offer fair control of this pest but with the development and acceptance of precision air planters, the use of dust has declined in order to prevent clogging of the small holes in the drill plates of the new planters. Cultural control practices include deep plowing to remove or decrease the amount of soil organic matter and the use of crop rotation to avoid following cover crops in early spring plantings. The pest is attracted to winter annual weeds, which need to be controlled. Diazinon has been effective as an in-furrow application.

Wireworms (*Limonius* spp. and others) are click beetle larvae that dwell in the soil. The pest has been found in all soil types in the melon production regions. Damage consists of feeding on roots and boring into plant stems. Wireworms are controlled fairly well with Diazinon granules incorporated into the soil. Diazinon can also be used with drip irrigation systems or sprinkler injected for coverage at seedling emergence. Crop rotation can be effective in reducing wireworm infestations in soil and common crops for this include safflower, beans, cotton, tomatoes, and corn. Plastic mulches have been used on fall planted melons in Coachella Valley in the desert to protect plants which are highly susceptible to the pest. In research trials, thiamethoxam (Platinum) has shown to be very effective for the sugar beet wireworm species.

Aphids can cause feeding damage to melons and can vector viral diseases. Green peach aphid (*Myzus persicae*) can be a problem in early spring. The major concern is the cotton/melon aphid (*Aphis gossypii*) in late plantings. Aphids are controlled very well by imidacloprid (Admire), but good coverage is critical. Pymetrozine (Fulfill) is a rather new compound so no usage patterns have been established in the pesticide tables in this report. Fulfill has been reported by PCAs to be very effective and soft on beneficial insects, but it is only registered for ground applications. Pyganic has been reported as a control option for melon aphids though it is not as effective as Hexacide (rosemary oil).

Whiteflies can be a problem throughout the season. Species compositions vary by geography. The silverleaf whitefly (*Bemisia argentifolii*) is the primary whitefly species in the desert production area while the greenhouse whitefly (*Trialeurodes vaporariorum*) is the species of concern in the south coastal area. Imidacloprid (Admire) provides excellent early-season control of these pests, although pest populations can build up later in the season and create problems. Insect pest resistance is a big concern for growers in all Areas. Whiteflies can transmit viruses that can do more damage than the actual insect feeding. Silverleaf whitefly is the primary vector for cucurbit leaf crumple virus (6).

Spotted cucumber beetles (*Diabrotica undecimpunctata*) and striped cucumber beetles (*Acalymma trivittatum*) particularly the larval stage, have started to become a problem throughout the northern production regions and especially for organic growers in the San Joaquin Valley. Spotted cucumber beetles have historically been controlled by organophosphate spray applications with Diazinon or with carbamates such as Sevin bait. A fairly new product, Adios, is registered for use but available usage data showns no use of the product. As overall pesticide use has been reduced through IPM, or changes in use patterns of specific materials have been implemented, the importance of various pest species has shifted. This may be the case with an increase of cucumber beetles as more vegetable crop production has replaced some small grain and cotton acreage. There are no documented cultural control strategies for either species (23).

Potential Problems in Early Season Melons

Beet leafhopper (*Circulifer tenellus*) can be a pest with some feeding damage done to young melon plants prior to the two true leaf stage but the biggest problem is that beet leafhoppers are the vector for curly top virus. Melons are not considered to be a suitable host for beet leafhoppers as the feeding is usually minimal but long enough to transfer the virus. Fallow field management is an effective means to manage infestation levels in melon fields close by to foothills of the coastal range, however there are economic concerns with leaving a field out of production. Lannate provides good control of leafhoppers, but it has very short residual activity. Malathion is the product effectively used in the state regulatory program for curly top virus control.

Western Flower Thrips (*Frankliniella occidentalis*) can damage melons with their rasping-chewing mouthparts during any stage of plant growth. Thrips are usually considered a minor pest.

Garden symphylans (*Scutigerella immaculata*), commonly referred to as garden centipedes, are an occasional pest that may damage young plants. The pest can be found in the same part of a field each year as the insect infestation slowly spreads to other parts. The pest can be a bigger problem in fields with high amounts of organic matter. Diazinon incorporated into the soil provides fair control.

Crickets (Field Cricket in the Gryllid Family & Mole Cricket in the Gryllotalpa Family) are occasional pests in late spring plantings in Area III and main season plantings from June through September in Areas I and II. Field crickets can damage young seedlings or transplants by feeding upon melon roots. Later in the growing season, crickets can chew deep holes into the fruit and can damage melons by staining fruit with their excrement (9). Mole crickets can damage drip irrigation equipment by chewing on plastic drip lines. Carbaryl bait remains the primary material that controls crickets when applications are made to control darkling ground beetles, flea beetles, and cucumber beetles.

Grasshoppers (Several species including desert locust) can be controlled by Sevin bait applications. Grasshoppers may become a problem in dry years when the pest migrates out of the foothills into the valley floor looking for plants to feed on.

Additional Information on Controls

Cultural Control: Crop rotations, sanitation, and the use of plastic mulches can be effectively used. No other new techniques reported.

Biological Control: No commercially acceptable techniques available or reported by the working group.

New Chemistry: Actara (a neonicotinoid) could be promising as this is not supposed to have cross-resistance with Admire. Platinum is a new product that could offer control of wireworms and seedcorn maggots.

A "TO DO" List for Management of Early Season Insects in Melons – Seeding to Emergence (listed in order of importance):

Research:

1) Evaluate alternatives to Diazinon for control of leafhoppers and soil-borne pest complex.
2) Evaluate carbamate alternatives for use in baits (e.g., neonicotinoids) and evaluate using young melon rinds as a substrate for Carbaryl (Sevin bait).
3) Evaluate efficacy of Thiamethoxam (Platinum) for control of cutworms and wireworms.
4) Evaluate effects of reduced tillage on early season pest problems.
5) Develop efficacy data for Pyganic, a botanical pyrethroid and identify pest species controlled. Identify other materials that organic growers can use for insect pest control.

A "TO DO" List for Management of Early Season Insects in Melons – Seeding to Emergence (listed in order of importance):

Regulatory:

1) Register alternatives to Diazinon for control of soil-borne pest complex.
2) Allow use of chemigation in melons to encourage adoption of drip irrigation.
3) Allow the continued use of Diazinon by melon growers with both aerial and ground applications.

Education:

1) Provide training on dust management when using various tillage techniques in windy areas.
2) Provide annual list of current registrations on melons.

Weed Management in Early Season Melons

Integrated weed control practices (cultural, hand weeding, chemical, etc.) are used in almost all melon fields. This process begins with field surveys to identify weed species and then appropriate practices and herbicides are selected. Weed control alternatives range from cultural to chemical. Cultural practices include crop rotation, cultivation, and hand weeding (hoeing). Water management, can be effective in reducing weed germination and this is one reason why drip irrigation is used in some melon regions in the state (15). Adjusted planting dates help to avoid competition from certain weeds (e.g., barnyard grass and dodder).

A variety of weed control practices may be used at different times of the year. There are four main timings for weed control activities: fall bed treatments, preplant, postplant, and layby treatments. The UC has published an excellent herbicide efficacy chart describing the use of these materials in the UC IPM Pest Management Guidelines: Cucurbits (2000).

Fall bed treatments are often applied to fields in preparation for early season planting (January to March). In these fields, winter rainfall may reduce 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 dry periods in early spring. In later plantings (April to July), non-selective herbicides, cultivation and preplant incorporated herbicides can all be used. More costly herbicides are applied as band treatments. Specific information on herbicide use for the years 1998-2001, along with a four-year average, can be seen in Tables 20-21 in the appendix for cantaloupes and in Tables 28-29 for mixed melons.

Fall Bed Treatments - Before Weeds Emerge

Cultivation, cover crops, and mulching with plastic are effective ways to manage fall weeds. Oxyfluorfen (Goal) can be applied to the entire bed by ground rig or aerial applications.

Fall Bed Treatments – After Weeds Emerge

Cultivation and hoeing are effectively used as management tactics in the fall after weeds have emerged. Some conventional and organic growers use flaming as a weed control technique but it can be both labor intensive and costly due to the high cost of propane. Flaming can be used on small weeds but is somewhat ineffective for control of tall grass species.

Chemicals effectively used at this time include paraquat (Gramoxone Extra), glyphosate (Roundup), and a Roundup/Oxyfluorfen (Goal) combination. If Goal herbicide is used, the beds will have to be worked prior to planting because of potential carryover problems in the root zone.

Roundup and Goal are broad-spectrum contact herbicides with activity on several weed species. Roundup is broader spectrum and picks up more of the grass species as compared to Goal, which is a very costly herbicide. Another good broadleaf herbicide is 2-4,D; however, its use is highly restricted due to drift concerns into nearby crops.

Preplant – Before weeds emerge

Cultivation is done as management tactics prior to planting. Several herbicides are used at this time for weed control: trifluralin (Treflan), metam-sodium (Vapam) and methyl bromide.

Postplant – After weeds emerge

Cultivation/soil covering and hoeing are options, as well as flaming. Sethoxydim (Poast) is used primarily for grass control.

Layby – After crop established and before weeds emerge

Layby treatments are done in direct seeded fields and chemical treatments include Eptam and Treflan, mainly for nutsedge and annual grass control.

Specific Weed Problems in Early Season Melons

Black Nightshade (*Solanum nigrum)* and Hairy Nightshade (*S. sarrachoides*) are two of the most common weeds infesting California melons in Areas I and II as they are not a problem in the desert region. Nightshades are in the same family as tomato and thus, most tomato herbicides are not effective against these weeds. Therefore, this family represents the most troublesome weeds in fields in Area II with regular rotation of tomatoes to melons. Preplant applications of metam-sodium (Vapam) with spray knives provide good nightshade control but are not practical for early season plantings due to the reentry period for planting that keeps crews out for 14 days (10). Methyl bromide has been reported to be non-effective in controlling nightshade species. Research work with Halosulfuron (Sandea) has identified good control of nightshades but the product is currently not registered in California melons.

Field Bindweed (*Convolvulus arvensis),* which is commonly referred to as perennial morningglory, is a troublesome perennial weed with a vining growth habit. Field bindweed infestations can smother melon plants as they out-compete the intended crop. This weed is also only a problem in Areas I and II. Cultivation with straight blading equipment down to a depth of 18-24 inches provides fairly good control but may need to be repeated several times prior to layby. Roundup used in early spring or late fall can provide god control on bindweed. Crop rotation is also used where feasible to control this weed but this control option is often limited due to water availability. Field bindweed can increase in fallow fields that are left out of production due to water availability.

Yellow nutsedge (*Cyperus esculentus)* and Purple nutsedge (*C. rotundus)* are perennial weeds reproducing primarily from tubers (commonly referred to as nutlets). Nutsedge infestations are very competitive and can substantially reduce all melon crop yields. Cultivation and hand weeding fail to provide lasting control as the weed quickly grows back into the beds. Regional differences occur in weed distribution. Purple nutsedge is primarily limited to the areas south of Madera County in Area II. Yellow nutsedge can be found throughout the state but it is considered to be more of a problem in Area I (15). Vapam can be used in drip irrigation systems, knifed into the beds, or used with flood irrigation provides good control. Halosulfuron is not registered yet but it has been reported that it provides excellent control of both species. Eptam performance varies from poor to good in control of nutsedge and its use as a fallow treatment depends on water content in the soil. Crop rotations can be effective when crops that grow taller than nutsedge are grown to out-compete the weed which is very susceptible to shade. Solarization and fumigation control techniques only provide partial control.

Common purslane (*Portulaca oleracea)* is an annual weed that is considered a cool-season weed. Purslane is considered to be the most widespread weed in vegetable crops. Most herbicides registered for use in melons for other target weeds such as annual grasses are ineffective and thus, hand labor with hoeing crews is also needed to manage this weed. Bensulide (Prefar) and ethalfluralin (Curbit) can be applied preplant as both materials provide good control of purslane.

Pigweed (*Amaranthus* spp.) is generally considered to be a secondary pest as it usually is controlled by the same methods as nightshades. Metam-sodium (Vapam), and EDTC (Eptam) provide good control, as does glyphosate (Touchdown).

Dodder (*Cuscuta spp.)* 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. Control generally involves cultivation by tractors for removal of the host plant or selective hand weeding by field labor crews. Trifluralin (Treflan) can be used as a spot treatment as it provides excellent control. Pre-irrigation in Area II allows germination of dodder that allows for control by cultivation equipment.

Summer annual grasses can be controlled by Roundup applications before the melon crop emerges. Prefar provides excellent control when applied preplant. Pre-irrigation of melon beds encourages weed germination so that herbicides can be used to control emerging and small weeds.

Cheeseweed or Little Mallow *(Malva parviflora)* can become a problem in Area II where preformed 80-inch beds are made in late fall. Repeated cultivations do not eliminate the deep-rooted taproot so the weed grows back after each pass with field equipment.

Volunteer Garlic is a problem that occurs when melons follow garlic in crop rotations in the San Joaquin Valley so this problem usually occurs only in Area II. The same type of problem can also occur when melons follow onions and the volunteer onions come up the next year. Numerous passes with cultivation equipment are usually necessary to control volunteer garlic/onions, as fallow bed applications of Goal herbicide does not provide control. Hand weeding crews may also be necessary to augment cultivations for adequate control.

Volunteer Melons is another weed problem that can occur when melons occur in successive plantings with no crop rotation. Pre-irrigation is used to germinate the volunteer melon seeds. As the volunteer melons emerge, most herbicides used for other weed control would eliminate the volunteers.

Volunteer Sugar Beets is another weed problem in Area II when melons follow sugar beets in crop rotation. Spot treatments of oxyfluorfen (Goal) herbicide and glyphosate (Roundup) are used for control.

Velvetleaf (*Abutilon theophrasti)* is an annual weed that has been reported to be more common in recent years in Area II. Halosulfuron (Sandea) is not yet registered for use in California melons but it has been reported that the material offers good control.

Mustard Family represents numerous weed species that includes mustards, London rocket, and shepherd's-purse. They are all annual weeds that can become a problem in fall and winter plantings. Oxyfluorfen (Goal) applied as a fallow bed treatment provides good control. Mustard can become a problem as it escapes trifluralin (Treflan) applications used for many other problem weeds. During the season, hand labor crews would be needed in several passes across a field.

Hand labor crews would also be used for control of minor annual weed pests such as sowthistle, lambsquarters, and ground cherry.

Melon production in Area III uses several different techniques to manage weeds. Growers of spring melons utilize a modified planting method called Yuma beds. After stand establishment, the beds are reworked into a more traditional melon bed. Weeds

can be controlled in the final bed formation. Another technique used by growers in the desert region is to use clear, plastic mulch

Additional Information on Controls

Cultural Control: No new techniques reported.

Biological Control: None indicated.

New Technology: Conservation tillage and precision cultivation.

New Chemistry: Halosulfuron – for postemergence control of nutsedge but this product needs to be registered in the state for use in melons. It has a federal label.

A "TO DO" List for Early Season Weed Management in Melons:

Research:
1) Biology and control options for nightshade, nutsedge, pigweed, and velvetleaf.
2) Evaluate Rimsulfuron with efficacy and phytotoxicity studies.
3) Evaluate Dual Magnum with efficacy and phytotoxicity studies.
4) Evaluate Dimethamide with efficacy and phytotoxicity studies.
5) Evaluate impact of different cropping systems on weeds.
6) Evaluate new chemical and biological herbicides.

Regulatory:
1) Register Halosulfuron (Sandea) for nutsedge control in the state.
2) Clarify label language for Treflan TR-10 use in melons.

Education:
1) Continue training on application techniques for Eptam.
2) Educate growers on crop/variety tolerances to Halosulfuron.

Diseases of Early Season Melons

A complex of organisms contributes to "damping off" or loss of emerging and very young plants. Organisms responsible for this syndrome include: *Rhizoctonia*, *Phytophthora*, and *Pythium*. In general, cool, damp conditions in combination with poor drainage and compacted soils will predispose a field to infection by these pathogens in Area II in March and April. Acremonium root rot has been reported to damage honeydews more than cantaloupes. Irrigation management and soil drainage play extremely important roles in reducing the threat from the damping off complex.

Verticillium wilt is also a widespread disease that can develop in the early part of the season. Field sanitation and reducing soil movement from adjacent fields into melon fields may reduce the potential for disease development.

Rhizoctonia, Phytophthora, Pythium, and *Verticillium* are all soil borne diseases in which the controls are basically the same for all. Good field and water management can significantly reduce problems caused by these pathogens. Promote is a new beneficial fungus that has been suggested as a biological control for these soil borne fungi, although UC personnel have developed no data. Effective chemical controls include metalaxyl (Ridomil) used through the drip system and metam-sodium (Vapam), which varies in efficacy according to proper application technique and soil moisture. Methyl bromide is used as a preplant fumigant in the desert production areas, however, this material is being phased out and additional research is needed on new and recently identified alternatives (i.e., chloropicrin and methyl iodide).

Additional Information on Controls

Cultural Control: There are a number of practices that can be used by growers to minimize risk from plant disease, such as using fields with good drainage and planting into high beds. Additional controls include: crop rotation, irrigation management, avoiding use of sprinklers in early spring or after early fruit development, proper fertilization (excessive nitrogen should be avoided), and minimizing soil compaction.

Biological Control: Promote and compost teas are reported to be effective.

New Technology: None reported.

New Chemistry: None reported.

A "TO DO" List for Management of Early Season Diseases in Melons:

Research:
1) Evaluate Blockade, a plant activator fungicide.
2) Evaluate seed treatments with fludioxonil and thiophanate-methyl (Topsin M).
3) Preplant fungicides for use at planting time are needed.

Regulatory:
1) Registration of Topsin-M is needed to replace benomyl (Benlate) for use with drip applications as foliar and in-furrow seed applications are already in place.

Education:
1) Educate growers on use of thiophanate-methyl (Topsin-M) as a replacement for benomyl (Benlate).
2) Disseminate information on Promote if available.

Nematodes in Early Season Melons

Root knot nematode (*Meloidogyne incognita)* is the major species of nematode of economic importance to melon production in California, although the closely related *M. javanica* may be present in some areas (9). High numbers of nematodes may build up in light texture soils where significant crop loss can be expected in susceptible host

plants. Nematodes cause a plant to develop shallow root systems that are unable to meet the great evapotranspiration demands brought on by hot temperatures.

Soil sampling and a knowledge of the history of a particular field will help to determine what preventative treatments need to be made to control this pest. Crop rotation and soil solarization are non-chemical techniques to prevent or reduce high numbers of nematodes in the soil. Soil solarization provides only fair control to within shallow depths and there are overlying economic concerns with using this technique because it takes a field out of crop production. The use of cover crops and leaving fields fallow can be effective, but these options are not always economically feasible given the cost of land and the price of the commodity. Chitin, a biological method to control nematodes, provides good control but takes a large amount of material and can be costly.

Several nematicides or soil sterilants with a range of efficacy are available for nematode control. Vapam is very effective. Methyl bromide is also very effective; however, the use of this material is being phased out. 1,3-Dichloropropene (Telone) provides good to fair control; however, township cap limits on the use of this product might be prohibitive to its use. Oxamyl (Vydate) provides only fair control of rootknot nematodes.

Additional Information on Controls

Cultural Control: Crop rotation, fallowing fields, the use of cover crops, and soil solarization have been used in some situations, otherwise, no new techniques have been reported.

Biological Control: No new techniques reported.

New Technology: No new techniques reported.

New Chemistry: Iodomethane (methyl iodide) needs California registration.

A "TO DO" List for Early Season Management of Nematodes in Melons:

Research:
1) Identify efficacy of methyl iodide as compared to standard nematicides.
2) Evaluate *Brassica* species and also the use of Marigolds for incorporation and solarization impact on nematode populations.

Regulatory:
1) Register Iodomethane (methyl iodide) for nematode control.
2) Request that the 1,3-dichloropropene (Telone) label include drip applications.
3) The current township cap limits for the use of 1,3-dichloropropene (Telone) has been a burden on melon growers, especially in parts of Area II. A fair resolution is needed.

Education:

1) Educate growers on the benefit of soil sampling for monitoring with lab analysis of nematode species so that effective control strategies can be implemented.
2) Training on the safe and effective use of methyl iodide and other alternatives to methyl bromide.

Vertebrate Pests of Early Season Melons

Horned Larks *(Eremophila alpestris*) are one of the most notorious bird species that are known to reduce melon stands when direct seeding is used (9, 11). The birds reduce the plant population by pulling up seedlings as they walk up the planted rows during feeding. 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 during daytime hours. 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 have become a bigger problem for growers since the introduction of hybrid seed with fewer seeds planted per acre. Growers who need to thin a melon field should delay thinning activities until plants achieve at least two true leaves. Larks are not a problem when transplants are used.

Rabbits (*Sylvilagus spp*.) may feed on melon seedlings from early spring through mid-summer. Bait stations with diphacinone baits have been effective in controlling the pest along field borders (9). Damage may be high when fields are located next to almond orchards. They are considered a minor pest as they reduce plant populations along borders where protective cover occurs which minimizes the threat from hawks and owls.

Ground squirrels (*Spermophilus beecheyi*) may damage melon seedlings in early spring planted fields that border almond orchards as they can chew on young plants. Ground squirrels usually do not make their burrows inside melon fields due to all the discing and cultivating activities. Bait stations with diphacinone baits have been effective in controlling the pest along field borders (9). Squirrels have also become a bigger problem in recent years for the same reason as other hybrid seed pests due to the lower plant populations of emerging seedlings (11).

Voles (*Microtus* spp.) are sometimes referred to as meadow mice or field mice. They are considered a minor pest in Area II where adequate plant cover is present to protect them from owl and hawk predation. Voles damage melon plants early in the growth cycle.

Pheasants have been a problem in Area I as they feed upon seedlings.

Pests of Established Melons (From Stand Establishment to Flowering and Fruit Development up to Harvest)

Insects and Mites in Established Melons

The value of melons is entirely dependent upon the quality of the crop and as a consequence of this, very little cosmetic damage can be tolerated, especially with

honeydews grown for the export market. Care must also be taken to monitor pests regularly and avoid secondary pest outbreaks, which arise from insecticide treatments.

Insect pests in established melons are controlled with standard pesticides such as organophosphates and carbamates; however, newer chemistries such as imidacloprid have also been shown to be effective for the control of sucking insects. Spinosad (Success) is a newer reduced risk compound that is showing great promise. *Bacillus thuringiensis* is a widely used microbial insecticide and pheromones used as population monitoring tools are effective tools. Insecticidal soaps have only been moderate in their level of effectiveness and this material is most effective when used on nymphs. Parasites, predators, and naturally occurring viruses have shown limited impact for biological control on high insect densities. Unfortunately, biological control has generally not been shown to be a commercially viable treatment option for many pest species present in melons. Due to the high value of the fruit and the low tolerance of damage by consumers, care must be taken to intensively manage insect damage using an integrated approach. IPM in melons thus incorporates many tactics, with great care given to decisions on which pesticides might be needed, since secondary pests can be very problematical in this crop.

Melon Aphids – (*Aphis gossypii*) Ladybugs and lacewings can be seen at times in great numbers in melon fields, but these beneficial insects usually only get to sufficient densities once significant damage has been sustained by the crop. For this reason, biological control has only been relied upon to a very limited degree in melon production. Neem oil, a material approved for use in organic systems, only provides poor control of aphids as does potash soap (M-Pede) as good coverage is necessary.

Dimethoate works fair to good for aphids. Fulfill, Imidacloprid (Provado and Admire) work well, but cannot be used late in the season because of PHI issues. Oxamyl (Vydate) provides good control as a drip application; this product is sometimes used as a foliar treatment because it controls several pest targets. Spinosad (Success) only provides poor to fair control of aphids. Methomyl (Lannate) is used with only poor to fair results and resistance has been reported with green peach aphids.

Whiteflies (*Bemisia argentfolii*) - Imidacloprid (Admire) applied early in the season works very well as it has PHI issues and cannot be used late in the season. The foliar form, Provado, can also be effective but it has been reported to be very hard on bees, therefore its use during pollination is very limited. Fenpropathrin (Danitol) and methomyl (Lannate) tank mixes and oxamyl (Vydate) only provide fair to good control of whitefly pests, while Neem oil is reported to provide poor control of this pest. Areawide crop scheduling is extremely important, particularly in desert growing regions where continuous cropping can provide “bridges” to new host material and whitefly buildup has been observed to be extreme.

Leafminers (*Liriomyza trifolii, L. sativa*, and *L. huidobrensis*) are small dipteran flies, which can cause considerable damage to melon leaves by their extensive tunneling into leaf tissue. These insects have been a problem in the central and northern melon growing regions. Abamectin (Agri-Mek) and cyromazine (Trigard) provide good to excellent control with low impacts on beneficicals; spinosad (Success) provides good to fair control.

Spider Mites have eight legs and therefore are not classified as insects, which have six legs. Two-spotted spider mites (*Tetranychus urticae*), strawberry spider mites (*T. turkestani*), and desert spider mites (T. desertorum) are all considered minor pests of melons. Mites feed on the stems and leaves of melon plants. Mite damage is most severe in hot weather when environmental conditions favor the pest and quicken the pace of the life cycle. Spider mites blow into a melon field from neighboring areas. Fields are monitored for bronzing on lower leaves and treatments are initiated when crop damage begins to spread. If the canopy has not fully developed across the bed, a ground rig could be used with dicofol (Kelthane) or abamectin (Agri-Mek). Organic melon growers have also noticed that the use of dusting sulfur had a suppressing effect upon mite colonies.

There are several biological control organisms such as predacious mites, thrips, ladybird beetles, and lacewings that are effective predators of spider mites (24). Predatory mite releases are effective when population densities are low to moderate. Continued releases are necessary to keep populations in check. Growers can also control spider mite populations by keeping roadways around fields watered down to limit dust movement onto the plant canopy.

Cabbage Looper (*Trichoplusia ni*) has become an annual problem in established melons. Like control of beet armyworm in melons, methomyl (Lannate), bifenthrin (Capture), permethrin (Pounce), and esfenvalerate (Asana) all provide good to excellent control of cabbage loopers, but may cause leafminer problems if applied early in the season. Bt applications can help to suppress looper populations if applied to small instar larvae. Spinosad (Success) has been used with only fair results but this product is good to use in rotational programs for resistance management.

Leafhopper (*Empoasca* spp.) can become a significant problem in established melons if large amounts of nymphs are present, as they reduce chlorophyll levels in melon leaves. Methomyl (Lannate) provides good control, but it has very short residual activity. Leafhoppers can be pests throughout the growing season so this species should be monitored the entire season. Diazinon is one of the only materials registered for leafhopper control on honeydews. Malathion is a product effectively used in the state regulatory program for beet leafhoppers (*Cirulifer tenellus*), which are not a problem for established melons.

Beet armyworm (*Spodoptera exigua*) – Methomyl (Lannate), permethrin, and Asana all provide good to excellent control of beet armyworms but may cause leafminer problems if applied early in the season. Confirm is a good material for beet armyworm and Bt applications (Xentari) if used at flowering can help to suppress populations. Spinosad (Success) has been used with only fair results and performance does not seem to be very consistent on this harder to control lepidoptera, but this product is still good a good choice in a rotational program to manage resistance.

Western Yellow Striped Armyworm (*Spodoptera praefica* and *S. ornithogalli*) can chew on and gouge out large areas of fruit as melon maturity approaches. Methomyl (Lannate), permethrin (Pounce), and esfenvalerate (Asana) all provide good to excellent control of armyworms but may cause leafminer problems if applied early in the season. Bt applications (such as Xentari) if used at flowering can help to suppress populations of small instar armyworm larvae. Armyworms need to be controlled prior to melon maturity

as the pest will attack maturing fruit and a single puncture wound into the melon flesh is enough to force the melon to be culled.

Spotted cucumber beetles (*Diabrotica undecimpunctata*) and striped cucumber beetles (*Acalymma trivittatum*) particularly the larval stage can be problems for established melons. Carbaryl (Sevin bait and Adios) can offer some control.

Darkling ground beetles *(Blapstinus* spp. and others) can cause chewing damage to the netting of cantaloupes as the melons approach maturity. Carbaryl (Sevin) is one of the few effective materials, along with pyrethroids such as permethrin (Pounce).

Cutworms, commonly referred to as strawberry cutworms, can attack ripening melons by burrowing into the bottom-sides of cantaloupes as the melons mature. There are several species of cutworms that impact on melon yields in Area II, especially along the Westside District of Los Banos, Firebaugh, and Mendota. Cutworms can be significant problems when melons planted in July follow small grain crops such as wheat or barley harvested in June. There are several cutworm species that may need to be controlled, including black cutworm (*Agrotis ipsilon*) and variegated cutworm (*Peridroma saucia*).

Stink Bugs are a minor threat to melons during fruit development. Consperse stink bug (*Euschistus conspersus*), southern stink bug (*Nezara viridula*), Says stink bug (*Chlorochroa sayi*), and several other species are considered by PCAs to be among the hardest insect species to control. Endosulfan (Thiodan) provides good to excellent control of this very migratory pest, however restrictions on its use near waterways limit its usefulness. Permethrin is registered, however this, like Asana only provides poor control of stinkbugs and tends to flare secondary pests. Potash soap and sanitation only provide poor to fair control of this pest.

Western Flower Thrips (*Frankliniella occidentalis*) can be managed with a fairly new material named Success, which provides very good control as does Admire but Admire has PHI issues. Neemix is reported to only provide fair results for thrips control. Pyrethroids such as esfenvalerate (Asana) can create leafminer flare-ups, so these materials are used judiciously. It is important to manage pesticide resistance when treating for thrips and the use of monitoring fields and adjacent vegetation is important. Weed control around the field is also important in reducing problems brought about by thrips. Early detection and removal of affected plants is effective in certain areas, especially in southern production regions.

Additional Information on Controls

Cultural Control: no new techniques reported.

Biological Control: no new biocontrols reported, use remains limited due to efficacy.

New Technology: pheromone technology can be effective in pest monitoring.

New Chemistry: neonicotinoids.

A “TO DO” List for Management of Insects/Mites in Established Melons:

Research:
1) Evaluate alternative to Diazinon for control of leafhoppers.
2) Evaluate control strategies for so-called pinworm damage prior to harvest from a complex of insects such as cutworms, earwigs, and arthropods such as centipedes and millipedes.
3) Evaluate melon varieties (Durango, Hymark, and others) for resistance to aphids.
4) Evaluate alternatives to bifenthrin (Capture) for worm and aphid control and alternatives such as Acramite for mite control.
5) Plant breeders need to develop melon varieties resistant to whiteflies.

Regulatory:
1) Obtain California registration for indoxacarb (Avaunt) for control of worms such as cabbage loopers as this material is currently in IR-4.
2) Maintain California registration for Diazinon for control of flea beetles, leafhoppers, and soil-borne insect pests.

Education:
1) Develop web site with photos of all insect pests identified in this strategic plan via the California Melon Research Board’s team.

Melon Pollination

All melons require pollination by honeybees in order to produce fruit because the pollen grains are large, sticky, and not moved by the wind (14). In the past, some growers used to rely upon feral bees for pollination of melons. But varroa mites and tracheal mites have decimated the native bee population in the state in recent years. In addition to these mite pests, European honeybees have been competing with the Africanized honeybee in southern California since 1994 (3). Prior to the entry of the Africanized honey bee in the state, growers used to have their beekeepers place bee hives inside, or nearby, melon fields whenever possible to decrease the length of the flight path. The placement of hives inside fields used to create problems for ground rig applicators and even aerial applicators as a 48-hour notice had to be given to a bee keeper prior to a pesticide application. Some beekeepers would then come out prior to a spray and cover the hives with plastic. Once the Africanized bee became established in the lower desert region, growers and beekeepers changed the hive placement strategy to keep hives at a distance away from workers. Now, most beehives are placed outside of the field along the perimeter or even along a nearby road. This lessened the threat to bees from spray drift while also keeping the majority of bees away from where workers are. Beekeepers have also taken an aggressive strategy to replace queen bees with a new European queen when a hive is suspected of being taken over by an Africanized bee swarm.

Bloom begins approximately four weeks after planting and continues up until harvest. Most growers have written contracts or verbal agreements with beekeepers to keep hives in a field for a specified time. Beehives are usually held in cantaloupe fields for 30 days and in honeydew and mixed melon fields for 40-45 days. Bees are removed once a harvestable crop has been set. Growers vary the rate of beehives from one-half to one hive per acre based on the melon type and the region. Some growers in the Imperial Valley do not put any beehives in the field and rely upon native feral bees or bees flying in from other fields.

Recent research has suggested that alfalfa leafcutting bees can be used to pollinate melons in California but this practice has not been brought into production fields (2). This type of bee is very sensitive to pesticides and should only be considered for use in warm summer months.

A "TO DO" List for Pollination Management in Melons:

Research:
1) Determine the optimal time for bees to be moved in and out of the field.
2) Develop new control strategies for Varroa and Tracheal Mites that impact on honeybees.

Regulatory:
1) Work with the bee industry to obtain California registrations for pest control materials for varroa and tracheal mites to rotate with menthol.

Education:
1) Timing of beehives to be moved in and out of fields.

Weeds in Established Melons

The most difficult weed species to manage in melons are nightshades, field bindweed, nutsedges, and annual grasses (15). Most registered herbicides are somewhat effective in control but hand labor is required to manage many of these species. A new herbicide (halosulfuron or Sandea) is showing great promise for nutgrass control in melons. Cultivation is used to control weeds up to the time of "layby." Layby is considered the stage of melon growth when cultivation equipment cannot be used anymore; melons are growing outward across the beds at layby. At layby, a preemergence herbicide is often applied to the area outside the seedline to control late emerging weeds.

Black nightshade (*Solanum nigrum*) and hairy nightshade (*Solanum sarrachoides*) are two weed species of concern to melon growers in Areas I and II. Most melon herbicides are not effective against nightshades. Hoeing and cultivation are non-chemical options for control of these difficult weeds.

Field bindweed (*Convolvulus arvensis*) and nutsedges (*Cyperus* sp.) – Only cultivation and hoeing are options for these weeds in established melons.

Annual grasses - Hoeing and cultivation are non-chemical options for control of grasses. Irrigation management also is an aid to managing several grass species. Poast is an effective grass herbicide.

Dodder (*Cuscuta* spp.) – Only hoeing, flaming, or rotating crops provide any control of this parasitic weed. Flaming isn't used very much due to high costs of labor and propane.

Velvetleaf (*Abutilon theophrasti*) – Hoeing, hand removal, and cultivation are non-chemical options for control of velvetleaf.

Purslane (*Portulaca oleracea*) - Cultivation and hoeing are options for these weeds in established melons. Treflan used as a layby treatment can offer control.

Puncturevine (*tribulus terrestris)* – A seed weevil is available as a biological control agent from some County Agricultural Commissioner's offices. The spines on the seeds of puncturevine can be very painful if embedded into the flesh of a melon picker's hands.

Groundcherry (*Physalis* spp.) – has a weak tap root with fibrous roots but the weed can grow to a height of over two feet. Oxyfluorfen (Goal) has some contact control and residual activity against the weed.

Additional Information on Controls

Cultural Control: No new techniques reported.

Biological Control: No new techniques reported or commercially available.

New Technology: Smart sprayer equipment for precision applications.

New Chemistry: Halosulfuron (Sandea).

A "TO DO" List for Weed Management in Established Melons:

Research:
1) Develop control measures for black and hairy nightshade.
2) Develop control measures for field bindweed.
3) Develop control measures for nutsedge.
4) Develop smart sprayer equipment for use with melons.
5) Identify depth of tillage equipment needed to impact on different weed species.
6) Develop post-emergent materials for control of broadleaf weeds.

A "TO DO" List for Weed Management in Established Melons:

Regulatory:
1) Ease 8-month plant-back restrictions on Halosulfuron (Sandea) and allow registration for use in melons.
2) Register paraquat and glyphosate for selective use in established melons.

Education:
1) Educate growers on use of Halosulfuron (Sandea).
2) Demonstrate use of cover crops and organic amendments and their effect on weed populations.

Diseases in Established Melons

The major diseases, which occur in established melons, include *Verticillium*, *Fusarium*, Macrophomina*, Phytophthora* root rot, *Pythium, Monosporascus* and powdery mildew (24). Viruses are a problem in many areas and insects such as aphids and whiteflies vector these. Vector control has not been a good strategy to manage disease incidence. Specific viruses of importance include cucumber mosaic virus, watermelon mosaic virus, papaya ringspot, and zucchini yellows mosaic virus (9). Rhizoctonia has been reported to be a late season problem in the desert region.

Verticillium/Fusarium – The use of aerially applied foliar nutrients helps to maintain plant health and develops plant canopies, thus somewhat reducing the incidence of these diseases. Preplant soil fumigation is sometimes used as a management strategy, as well as resistant varieties.

Powdery mildew was formerly referred to as *Sphaerotheca fuliginea* but recently it has been referred to as *Podosphaera xanthii* (Castagne) U. Braun & N. Shishkoff *comb. nov.* in scientific literature (17). Powdery mildew is a disease that is expressed when the crop is stressed by environmental factors such as high temperature combined with poor soils, salts, and irrigation problems. The disease can appear in all melon production regions of California. Disease development is favored by high relative humidity associated with mild air temperatures. High daytime air temperatures favor disease expression and damage. Best growing practices aimed at minimizing plant stress are suggested to reduce impact from the powdery mildew pathogen.

Rally only provided fair preventative control of powdery mildew. Dusting Sulfur is fair to good in performance as long as daytime air temperatures remain above 85 degrees Fahrenheit. Systemic Acquired Resistance (SAR) type products (e.g., Messenger, a harpin protein) may help plants to sustain or resist infection by this disease but research is needed to verify this. Prior to the development of sulfur resistant melons, growers used triadimefon (Bayleton) fungicide in attempts to control powdery mildew in melons in California. But the triadimefon label stated that it did not control *Sphaerotheca fuliginea* (10). Sulfur is now the most widely used fungicide in all melon types (see previous Tables 2-3) while triadimefon use has been greatly reduced (20). Aerial operators make most applications at nighttime as sulfur has a fire hazard associated with air temperatures above 90 degrees Fahrenheit. A new biofungicide, *Ampelomyces quisqualis* (isolate M10 being marketed as AQ10 by Ecogen) has been reported to reduce spore production but not affect the size of colonies of *P. xanthii*. Chlorothalonil (Bravo or Echo720) has several labels, which are technically equivalent, and they are labeled for powdery mildew control.

Phytophthora / Pythium root rot – These soil-borne pathogens attack roots late in the growing season and their activity is favored by over-watering. Therefore, avoiding over-

watering is the best way to manage the onset of this disease in established melons. Preplant soil fumigation has been used as a management strategy. Metalaxyl (Ridomil) provides fair to good control of Phytophthora root rot disease.

Viral Disease Complex consists of aphid vectored Cucumber Mosaic Virus (CMV), Watermelon Mosaic Virus (WMV), Zucchini Yellow Mosaic Virus (ZYMV), Papaya Ringspot Virus (PRSV), and Cucurbit Aphid-Borne Yellows Virus (CABYV) (9). The complex also includes Squash Mosaic Virus which is vectored by the spotted cucumber beetle (*Diabrotica* spp.). Squash Mosaic Virus is also seedborne so cultural control of this disease includes using virus-free seed for elimination of the primary inoculum (24). Insecticide use for control of insect vectors has not stopped the transmission of viruses into all melon types. When viruses impact on a melon field, symptoms can range from mild to severe depending on the stage of growth. Aphid infestations can vary from year to year and attempts to destroy alternate hosts such as weeds and crops finished with harvest can help in area-wide pest management. Cultural alternatives to the use of pesticides include the use of silver-colored reflective, plastic mulch. The high cost of plastic, installation, removal, and disposal of the plastic mulch has limited its use in large-scale melon production fields. Vector control (e.g., aphids, and whiteflies) has been met with little or no success for reducing virus problems in established melons. No widespread resistances to all viruses have been bred into melon varieties.

Charcoal Rot (*Macrophomina phaseolina*) is another soil-borne pathogen that attacks established melons with heavy fruit loads late in the season. The fungus is favored by environmental conditions with hot air temperatures that force stress on melon plants from a lack of moisture combined with high levels of salinity in the topsoil. It has been suggested that the pathogen occurs more frequently under melons grown with drip irrigation than furrow irrigated crops. The disease has been reported to be more frequently encountered in fall melons in Area III and summer melons in Area II.

Vine Decline (*Monosporascus cannonballus)* is a destructive root pathogen in established melons, particularly in the desert production regions of Area III. Control strategies include preplant soil fumigation to reduce soil inoculum levels, and post-harvest root destruction strategies to prevent pathogen reproduction on infected roots after crop termination.

Fusarium fruit rot can be a big problem in the spring harvest in Area III but it can also be a problem in the fall harvest too. Field reports of losses of up to 30% or more of the melon fruit have been reported by a PCA working in the desert region. It has been reported to be a big problem with drip irrigated fields but it can also impact on furrow irrigated fields too.

Additional Information on Controls

Cultural Control: Irrigation & fertilizer management may be effective for some diseases.

Biological Control: No new products are commercially available.

New Technology: Systemic Acquired Resistance products such as harpin proteins.

New Chemistry: Strobilurins are new and effective, but resistance management is key.

Triflumizole (Procure) is currently available for cucurbits in most states and is scheduled to be available on cucurbits in California in 2003.

A "TO DO" List for Disease Management in Established Melons:

Research:

1) Continue study of whitefly transmitted gemini-viruses.
2) Evaluate resistance of *Pythium* to metalaxyl (Ridomil) and mefenoxam (Ridomil Gold).
3) Evaluate effectiveness of fosetyl-al (Alliette/nutriphyte) on *Phytophthora* with a comparison to Messenger.
4) Develop melon varieties resistant to races of *Verticillium* and *Fusarium* found in California as there has been suggested resistance by seed companies but this has not been confirmed.
5) Identify proper post-harvest crop destruction strategies to control root rot and vine decline diseases.
6) Identify Fusarium fruit rot control methods.
7) Evaluate AQ10 biofungicide *Ampelomyces quisqualis* for control of powdery mildew.
8) Evaluate chloropicrin in the San Joaquin Valley for possible control of soil-borne pathogens.

Regulatory:

1) Register methyl iodide (iodomethane or Midas from Arvesta Corporation) as an alternative to methyl bromide.
2) Evaluate the long-term viability of the curly top virus control program operated in the state without melon producers paying assessments for a disease that hasn't been confirmed in recent years to be a problem for melon producers.
3) Expedite the registration of Triflumizole (Procure) fungicide for control of powdery mildew in California. (Possible registration in 2003).

Education:

1) Demonstrate post-harvest crop destruction benefits in field production settings (not just in small, research plots) and educate growers on the necessity for the immediate destruction of plant residue (including roots) after crop termination. Many plant pathogens, including those that infect roots, multiply rapidly on crop residue. Foliar application of an herbicide or the use of a flail mower to destroy the crop canopy are, however, counterproductive and actually enhance pathogen reproduction in infected roots.
2) Help define resistance management strategies for powdery mildew.

Nematodes in Established Melons

Root knot nematode is the major species of nematode of economic importance to established melons in California, although the closely related *M. javanica* may be present in some areas. High numbers of nematodes may build up in light texture soils

where significant crop loss can be expected in susceptible host plants. Nematodes cause a plant to develop shallow root systems that are unable to meet the great evapotranspiration demands brought on by hot temperatures. Therefore, melon crops can suffer severe damage from nematodes from fruit development up to maturity when the crop is carrying a large amount of fruit.

A "TO DO" List for Management of Nematodes in Established Melons:

Research:
1) Evaluate avermectin (Agri-Mek) as a drench application as an alternative for nematode control.
2) Evaluate oxamyl (Vydate) for nematode control after planting.

Regulatory:
1) Register Iodomethane (methyl iodide) for nematode control.
2) Retain as many existing alternative materials as possible to facilitate a pest resistance management program for nematodes.

Education:
1) A literature search is needed for information on neem oil (Neemix) as a control option for nematodes.

Vertebrate Pests of Established Melons

Pocket Gopher (*Thomomys* spp.) activity should be monitored along field borders, as this is where most gopher damage occurs in melon fields. Gophers can damage melon plants by their burrowing activity and by feeding on roots. They also can damage irrigation canals. Special tractor driven field implements can be used to create artificial gopher tunnels for use with strychnine or anti-coagulant baits prior to planting (9). Providing nesting sites along field borders can encourage predation of gophers by owls but this method of control hasn't been extensively established.

Coyotes (*Canis latrans)* can damage drip irrigation equipment by chewing through lines in order to get to a water source. Damage from coyotes chewing on drip irrigation equipment adds to maintenance and repair costs. Coyotes also do minor damage to all melon types as they chew on fruit close to harvest times. Coyotes are only partially controlled by trapping but this control method is rarely used. No other control options have been employed (9).

Crows (Corvus spp.) damage melons in the harvest ready stage as the birds peck into the fruit in attempts to get the seed. When a single puncture wound has been made into the flesh, the melon is unfit for harvest. Once they have established a feeding pattern, crows will not be scared away with noisemakers such as propane cannons or even shooting (9). If they do fly off, it may be only for a short distance.

Voles (meadow mice), rabbits, and squirrels may cause minor problems to an established melon crop. These pests can do direct damage to the harvestable crop. Poison baits and pellets are registered for some of these pests and can be highly effective but their use would only be outside of fields. Voles were formerly controlled with a product called Ramik Green. The registration status of this product needs to be

clarified. Lethal control works well for squirrels and is also available for gophers (phosphine gas). Bait stations only work fairly well for a number of vertebrate pests including voles, gophers and squirrels.

Additional Information on Vertebrate Control in Established Melons

Cultural Control: No new techniques reported.

Biological Control: Owl predation of gophers can be encouraged by building and providing adequate nesting sites along melon field borders.

New Technology: No new techniques reported.

New Chemistry: No new techniques or products reported.

A "TO DO" List for Vertebrate Control in Established Melons:

Research: No needs reported at this time.

Regulatory:
1) Obtain consistency of issuance of depredation permits.
2) Need to determine status of several formerly used lethal controls.

Education:
1) Provide grower updates on vertebrate pest control options.

Plant Growth Regulators

Ethephon (Ethrel) as a Plant Growth Regulator is used as a ripening agent for melons in Area III. Ethephon promotes abscission or slipping of the fruit off the vine. This makes for a more efficient and economical harvesting with fewer passes across the field. The first harvest would be expected at two to six days after application, depending on air temperatures. The higher the air temperatures, the faster the effect of ethephon on cantaloupes. Ground rigs are used to apply ethephon, as aerial applications are not permitted except in the state of Texas. No data on usage patterns was found in a search of the pesticide database but growers and PCAs reported use of ethephon in cantaloupes. Cantaloupe fruit quality for melon flesh color or soluble solids (sugar content) is not improved following ethephon applications.

Messenger, a harpin protein, may help plants to protect themselves by activating stress defense responses that enable a plant to increase its overall vigor and stamina. The active ingredient in Messenger (from EDEN Bioscience) is Harpin *Ea,* which is reported to be identical to a protein that occurs naturally. The manufacturer reports that the product is nontoxic to both humans and the environment. The material may be able to boost overall crop production in melons.

Fruit Maturity and Harvest

Harvest of melons has as many variations as growers can think of with modifications to both field packing and shed packing operations. Nowadays, most cantaloupes are harvested by hand crews who pick fruit at full-slip as they follow behind a tractor pulled packing machine. Cantaloupes detach from the main stem of the plant when they reach full maturity. When fruit maturity approaches, the stem slowly starts to separate from the cantaloupe fruit. When a melon picker picks up a cantaloupe, the melon should easily detach from the stem if it is ripe. When this happens, the stem end of the cantaloupe will have a completely round area that shows that the plant released the melon and thus it had a full-slip. If the melon is not mature, and the picker picks the melon anyways, a portion of the stem would remain in the stem end. Depending on how much stem tissue is still attached at the stem end, the melon would be considered to be at half-slip or quarter-slip stage. Ripe melons at full-slip would easily separate from the vine without any use of cutting knives. Honeydews and mixed melons do not slip off the vine, they are cut with knives. The pickers would then place the melon onto a wing or belt assembly supported by the main unit as the melons would roll down towards the packer. Most cantaloupe fields are picked once a day with a harvest period commonly across 10-14 days.

Fields are ready for harvest once they have met the approved standards according to a legal maturity index for sugar development. Melon quality is primarily based on uniform shape and the absence of injury or handling defects. Firmness is also a component of quality. Size is not a factor of grade quality, but may strongly influence commercial quality expectations.

Post-Harvest Diseases

Forced air cooling is used on almost all cantaloupes. The older packing sheds used to utilize hydro-cooling with cantaloupes dumped into water baths to remove heat from the melons. All of the newer facilities being built for vegetable storage are designed around air cooling with automated computer controls. The air temperature is usually no lower than 38 degrees Fahrenheit (3.3 degrees C) as cantaloupes are typically held for four hours in a cooler. Once the cartons reach the desired temperature, a forklift operator would move the pallets out of the cooler directly into refrigerated trucks ready for transit.

Post-harvest activities involve washing of shed packed honeydew fruit in wash or dump tanks where chlorine is added to water which is slightly warmer in temperature than the product in order to prevent water uptake and also entry of decay-causing organisms. Washing is performed prior to sorting and packing operations. Food grade wax may be applied to export honeydews to replace naturally occurring waxes removed in the washing and cleaning operations. This also improves appearance and reduces water loss. There is no washing of produce in water baths in any melon type that is field packed.

Melons are sensitive to a few environmental and genetic disorders, which may develop during post-harvest ripening or post-harvest storage. Fertilizer and irrigation management, weather conditions, insect feeding injury, asymptomatic virus infection, and unknown agents may all interact to affect post harvest quality.

The following organisms (disease) may cause post-harvest loss in melons:

- Black Sooty Mold
- Cladosporium

Additional Information on Post-Harvest Disease Control in Melons

Cultural Control: No new techniques reported.

Biological Control: None available.

New Technology: No new techniques reported.

New Chemistry: No new techniques or products reported.

A "TO DO" List for Post-Harvest Disease Control in Melons:

Research:

1) Need to develop safe and effective post-harvest chemicals and techniques with cost analysis.

Regulatory:

1) Government should provide or conduct post-harvest residue testing (take this burden off of growers) with special emphasis on melons imported from Mexico.

Education:

1) Educate growers on best management practices since this impacts post harvest quality more than any other thing.

Food Safety

Prevention of microbial contamination of fresh produce is favored over reliance on corrective actions once contamination has occurred. Microbial contaminants of potential or perceived concern in melon production include *Salmonella spp., E. coli, and Listeria spp.* Current techniques and products used to minimize contamination include: prevention, field sanitation, chlorinated water baths, use of proper cooling, worker hygiene, clean packing facilities and transportation.

Traceback mechanisms are in place, however this system breaks down after receivers ship the produce and boxes are broken down at retail outlets (commingling occurs).

Food borne illnesses associated with fresh produce consumption have been an increasing occurrence. Sources of microbial contamination include soil, water, manure, fertilizer, air, equipment, and produce handlers. Produce is exposed during transportation, cooling, packing, storage and secondary handling.

Many produce buyers are now requiring third party audits and certifications that show that melons are free from pesticide residues and post-harvest pathogens.

A "TO DO" List for Food Safety Issues in Melons:

Research:
1) Prevention of *Salmonella* spp. remains the top priority.
2) Publication of food safety protocol for melon producers and handlers written in laymen's terms.

Regulatory:
1) No new registrations or regulatory issues noted at this time besides more careful monitoring of Mexican melon imports.

Education:
1) Train workers on the value to keeping packing facilities clean.
2) Develop a communications plan to assure consumers that California cantaloupes and other melon types are safe to eat.
3) Develop a training program for food service handlers, with a special emphasis on cut fruit.
4) Add food safety publications in laymen's terms to the California Melon Research Board's web site.

International Trade and Export Issues

Approximately 20% of California honeydews are exported, with primary destinations being Pacific Rim countries such as Japan. While some recent movement towards establishing international tolerances (MRLs = maximum residue levels) for pesticides has been discussed in recent years by the EPA, significant progress towards harmonizing regulatory standards with other countries has not been made. The North America Free Trade Act (NAFTA) Technical Working Group on Pesticides has started to convene on these issues. As world food sources are more globally sourced, our own regulatory agencies, US-EPA, USDA, and FDA and their foreign counterparts must address food safety with regard to pesticide residues.

The Codex Alimentarius Commission was created by two United Nations organizations in 1962. The Food and Agriculture Organization (FAO) and the World Health Organization (WHO) serve as the major international mechanisms to encourage trade in food while promoting the health and economic interests of consumers. The US Codex Office is located in the Food Safety and Inspection Service at USDA in Washington, DC.

Presently it takes approximately 8 years to obtain an MRL through the Codex system. This is problematical in that while the Food Quality Protection Act of 1996 encourages the US grower community to move towards reduced risk compounds, an international registration for these materials may lag behind for several years. It is unclear at this point as to how this situation will be handled once a crisis arises, however commodities which increasingly deal with exports must address this issue as soon as possible.

- Current export markets are: Japan and Hong Kong for honeydews and Canada and Mexico for some cantaloupe shipments.

- Future potential export markets include: other Pacific Rim countries.

A "TO DO" List for International and Export Issues in Melons:

Research:
1) No needs reported at this time.

Regulatory:
1) The melon industry needs USDA and EPA to be aware that California farmers are faced with a threat from Mexican melon growers who are able to use pesticides that are not allowed in production in the state. California melon farmers need regulatory action that would keep a level state of competitiveness for all melon producers in the U.S. without unfair conditions developing because of a lack of registrations in California.

2) Insure that all new pesticides registered for melons are within NAFTA and Codex provisions in advance of trade opportunities.

Education:
1) No needs reported at this time.

Critical Pest Management Needs for the California Melon Industry

Listed in order or importance, the following list highlights those issues that have been identified as critical to the viability of the cantaloupe, honeydew, and mixed melon industries in California.

Research Priorities: Finding practical solutions to insect control are of immediate and serious concern to producers of melons in California.

1) Of paramount importance is the need to find effective alternatives to rotate with Diazinon for both leafhopper and soil-borne pest control.
2) Vector biology/disease management. (whiteflies/infectious virus, leafhoppers/curly top, and aphids/Poly viruses).
3) Develop alternatives to rotate with organophosphates and carbamates for soil pests.
4) Development of pest resistant melon varieties needs to be encouraged, advanced, and incorporated into existing seed development research. Plant breeding research should find and develop new varieties that are resistant to the many plant diseases and insect pests that are problems.
5) Develop new technologies and techniques to manage field bindweed, nutsedge, and nightshade.

Regulatory Priorities: The most important action that needs to be done involves an enhanced interaction between Cal-EPA and US-EPA. Harmonization should be

encouraged to facilitate and hasten the concurrent registration of reduced risk products. Concurrent registrations need to be brought into California in a more timely manner to eliminate the disadvantage that occurs when new materials get registered first in other states.

In terms of specific registrations, the melon industry needs:
1) New products registered to rotate with Diazinon for leafhopper control and to prevent insect pest resistance,
2) New chemistries for powdery mildew control and overall disease resistance management,
3) Clarify label issues for melon types on all pesticides.

Educational Priorities:

1) Educate government agencies on unfair trade/cultural practices, which result from regulatory burdens.
2) Educate regulators and consumer groups on IPM and cultural practices, especially as this information relates to risk assessments for crop protection tools.
3) Educate the general public on how IPM is used in agriculture and the impact of FQPA on the cost of food.
4) Identify crops and production areas where a crop free period could be implemented for grower education of area-wide pest management.
5) Continue emphasis on the "5 a Day" and "Buy California" Programs.

IR-4 Project Information Relative to California Melons

The following information summarizes the IR-4 status for registration and research issues of importance to the California melon industry. Project requests will be made to IR-4 through Pesticide Clearance Request (PCR) forms. Only compounds that have been identified by manufacturers to be possible materials for registration have been listed.
IR-4 Crop Group is Cucurbit Vegetables (09A = Melon Sub-Group).

The current registration of Rally fungicide is a Section 3 label that is still in force. Rohm & Haas had expected to complete the tolerance work on melons to take it from a temporary tolerance to full tolerance. When Dow acquired Rohm & Haas, the work on the tolerance was not completed. In 2002, IR-4 agreed to assist with the tolerance work.

Short term critical needs	Leafhopper materials – alternatives to Diazinon Soil-borne pest controls
Long term needs	Powdery mildew materials, herbicides to control nutsedge and perennial morningglory

A "TO DO" List for Growers/IR-4 in Melons:
Research Needs:
1) Evaluate permethrin (Pounce) on fruit pests at melon harvest.

Pesticide Clearance Request Forms Needed From Growers:
1) Proclaim PCR

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APPENDICES

Table 4

California Melon Production Statistics – Year 2000
Harvested Acreage

County	% of State Total	Cantaloupes	Honeydews	Mixed	Total
Fresno	41.9	28,700	3770	1670	34,140
Imperial	18.1	12,421	2,293	0	14,714
Kern	2.3	1,330	0	530	1,860
Kings	1.0	838	0	0	838
Merced	10.4	7,168	0	1,340	8,508
Riverside	7.7	4,100	1,039	1,122	6,261
San Joaquin	0.7	0	0	600	600
Stanislaus	6.1	3,510	690	780	4,980
Sutter	5.3	0	4,356	0	4356
Yolo	5.3	0	4,342	0	4342
Sum of Others	1.1	50	180	652	882
STATE TOTALS	100	58,117	16,670	6,694	81,481

Production (Cartons/Acre*)

County	Cantaloupes	Honeydews	Mixed	
Fresno	660	1,186	533	
Imperial	403	508	0	
Kern	735	0	661	
Kings	840	0	0	
Merced	535	0	520	
Riverside	545	679	550	
San Joaquin	0	0	565	
Stanislaus	446	610	404	
Sutter	0	506	0	
Yolo	0	556	0	

*Carton Equivalents: Cantaloupe = 40 lb. Honeydew = 29 lb. Mixed=33 lb.

Crop Value (in Thousands of Dollars)

County	Cantaloupes	Honeydews	Mixed	Total
Fresno	78,660	20,057	4,131	102,848
Imperial	30,714	4,633	0	35,347
Kern	5,054	0	1,733	6,787
Kings	2,968	0	0	2,968
Merced	17,289	0	2,754	20,043
Riverside	12,915	3,181	3,104	19,200
San Joaquin	0	0	1,750	1,750
Stanislaus	8,795	1,207	764	10,766
Sutter	0	8,225	0	8,225
Yolo	0	7,847	0	7,847
Sum of Others	195	381	2,027	2,603
STATE TOTALS	156,590	45,531	16,263	218,384

Source: County Ag Commissioner's Data/ CA Ag Statistics Service 2001

Table 5

Cultural Activities Profile for California Melons: Sacramento & San Joaquin Valleys												
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Bed Prep												
Weed Control												
Transplant												
Seeding/Capping												
Cap Removal												
Pre-thinning Cultivation												
Thinning												
Fertilization												
Cultivation												
Pollination												
Irrigation												
Hand Harvest												

Table 6

IPM Activities and Plant Monitoring Profile for California Melons: Sacramento & San Joaquin Valleys												
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Soil Sampling												
Irrigation Scheduling												
Petiole Sampling												
Insecticide App.												
Herbicide App.												
Fungicide App.												
Insect Scouting												
Disease Scouting												

Note: Information based on grower and Pest Control Adviser experiences.

Table 7

Cultural Activities Profile for California Melons: Desert Valleys												
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Bed Prep												
Transplant												
Seeding/Capping												
Cap Removal												
Pre-Thinning Cultivation												
Thinning												
Fertilization												
Cultivation												
Pollination												
Irrigation												
Hand Harvest												

Table 8

IPM Activities and Plant Monitoring Profile for California Melons: Desert Valleys												
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Soil Sampling												
Irrigation Scheduling												
Petiole Sampling												
Insecticide App.												
Herbicide App.												
Fungicide App.												
Insect Scouting												
Disease Scouting												

Note: Information based on grower and Pest Control Adviser experiences.

Table 9. Melon Seasonal Pest Occurrence: Sacramento & San Joaquin Valleys

INSECTS/MITES	J	F	M	A	M	J	J	A	S	O	N	D
Silverleaf Whitefly												
Aphids												
Cabbage Looper												
Armyworms												
Cutworms												
Leafhoppers												
Leafminers												
Spider Mites												
Darkling Ground Beetles												
Seed Corn Maggots												
Wireworms												
Cucumber Beetles												
Grasshoppers												
Crickets												
Dried Fruit Beetles												
DISEASES	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Mosaic Virus Complex												
Powdery Mildew												
Monosporascus												
Fusarium												
Verticillium												
Damping Off Complex												
Acremonium												
Macrophimina												
WEEDS	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Nightshade												
Field Bindweed												
Nutsedges												
Pigweed												
Purslane												
Dodder												
NEMATODES	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Root Knot Nematode												
VERTEBRATES	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Horned Larks												
Crows												
Gophers												

Table 10. Seasonal Pest Occurrence in California Melons: Desert Valleys

INSECTS/MITES	J	F	M	A	M	J	J	A	S	O	N	D
Silverleaf Whitefly												
Aphids												
Cabbage Looper												
Armyworms												
Cutworms												
Leafhoppers												
Leafminers												
Spider Mites												
Darkling Ground Beetles												
Seed Corn Maggot												
Wireworms												
Cucumber Beetles												
Flea Beetles												
Grasshoppers												
Crickets												
DISEASES	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Mosaic Virus Complex												
Powdery Mildew												
Monosporascus												
Damping Off Complex												
Pythium Macrophomina												
WEEDS	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Nightshades												
Field Bindweed												
Nutsedges												
Pigweed												
Purslane												
Dodder												
NEMATODES	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Root Knot Nematode												
VERTEBRATES	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Horned Larks												
Crows												
Gophers												

Table 11

Efficacy of Insect/Mite Management Tools Used in California Melons																		
Product	**Trade Name**	Silverleaf Whitefly	Aphids	Cabbage Looper	Armyworms	Cutworms	Leafhoppers	Leafminers	Spider Mites	Seedcorn Maggots	Wireworms	Cucumber Beetles	Crickets	Grasshoppers	Thrips	Dried Fruit Beetle	Darkling Ground Beetles	Flea Beetles
Abamectin	Agri-Mek	F	P	F	P		P	E	E									
Azadirachtin	Neemix	P	P	P	P		P	P	P									
Bacillus thuringiensis	Bt	P	P	G	P	F/G	P	P	P									
Bifenthrin	Capture	F	G	G	F		P	P	F				G	G	F		G	
Carbaryl	Sevin Bait	P	P	P	P	E	P	P				F	G	G		F	G	
Cyromazine	Trigard	P	P	P	P	P	P	E										
Diazinon	Diazinon	P	G	P	P	P	E	P										G
Dicofol	Kelthane								G									
Dimethoate	Dimethoate	P	F		P		F	P		G	G							
Endosulfan	Thiodan	G	G	G	F		G	P		G	G							
Esfenvalerate	Asana XL	F	P	F	P	G	P	P							F		G	
Imidacloprid	Admire	E	E	P	P		E	P		G	G	F			E		G	
Methomyl	Lannate	P	P	F	G	G	G	P		G	G						G	
N-methyl Carbamate	Adios											G						
Oxamyl	Vydate	F	F	P	P		F	F		G	G						G	
Permethrin	Pounce	R	P	F	P	G	P	P	G	F	F							
Potash Soap	M-Pede	P	P	P	P	P	P	P		P	P							
Pymetrozine	Fulfill		G															
Spinosad	Success	P	P	E	E		P	G							G			
Sulfur	Sulfur	P	P	P	P		P	P	F									

Data based on collective field observations and experiments by growers, Pest Control Advisers, and University of California Cooperative Extension Farm Advisers.

Rating System
E = Excellent G = Good F=Fair P=Poor/None R=Known Resistance

Table 12

Efficacy of Non-Chemical Insect Management Tools Used in California Melons																	
Non-chemical Tools	Silverleaf Whitefly	Sweetpotato Whitefly	Aphids	Cabbage Looper	Armyworms	Cutworms	Leafhoppers	Leafminers	Spider Mites	Seedcorn Maggots	Wireworms	Cucumber Beetles	Crickets	Grasshoppers	Dried Fruit Beetles	Darkling Ground Beetles	Flea Beetles
Cover Crops	P	P		P	P	P		P								P	
Habitat management																	
Monitoring/use of action thresholds	G	G	G	G	G		G	G									
Natural enemies	P	P	P	P	P/F	P	F	P	P	P	P	P	P	P	P	P	
Nutrition																	
Sanitation	F	F		F	F			F					F		F	F	
Soil/dust management	P	P		P	P				F/G								
Use of models				F	F	F											
Resistant varieties	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Water management	P	P	P	P	P	P	P	P	F	P	P	P	P	P	P	P	
Weed control						F					F						
Mulching										F	F						
Trap Crops																	
Netting																	
Mating Disruption					E												
Pheromone (monitor)				E	E	E											

Data based on collective field observations and experiments by growers, Pest Control Advisers, and University of California Cooperative Extension Farm Advisers.

Rating System
E = Excellent G = Good F=Fair P=Poor/None R=Known Resistance

Table 13

Relative Toxicity of Insecticides to Beneficial Organisms in California Melons									
Product	**Trade Name**	Big-eyed Bugs	Damsel Bugs	Green Lacewings	Lady Bird Beetles	Minute Pirate Bugs	Parasites	Spiders	Syrphid Fly Larvae
Abamectin	Agri-Mek	S	S	S	O	S	O	U	S
Azadirachtin	Trilogy	U	U	M	M	U	M	U	U
Bacillus thuringiensis	Bt	O	O	O	O	O	O	O	O
Bifenthrin	Capture	H		H	H	H	H		H
Carbaryl	Sevin	H	H	H	H	H	H	H	H
Cyromazine	Trigard	O	O	O	O	O	O	O	U
Diazinon	Diazinon	H	H	H	H	H	H	H	H
Dicofol	Kelthane	O	O	O	O	O	O	U	O
Dimethoate	Dimethoate	H	H	H	H	H	H	H	H
Endosulfan	Thiodan	H	H	U	U	H	S	U	U
Esfenvalerate	Asana XL	H	H	H	H	H	H	H	H
Imidacloprid	Admire	O	O	O	O	O	O	O	O
Malathion	Malathion	M	M	M	M	M	M	U	M
Methomyl	Lannate	H	H	H	H	H	H	H	H
Oxamyl	Vydate	M	M	M	M	M	M	U	M
Permethrin	Pounce	H	H	H	H	H	H	H	H
Potash Soap	M-Pede	O	O	O	O	O	O	O	O
Spinosad	Success	S	S	S	S	S	S	S	S
Pymetrozine	Fulfill	O	O	O	O	O	O	O	O

Data based on collective field observations and experiments by growers, Pest Control Advisers, and University of California Cooperative Extension Farm Advisers.

Rating System
U= Unknown O= No Effect S= Soft M= Moderate H= Harsh

Table 14

Efficacy of Disease Management Tools Used in California Melons									
Product	**Trade Name**	Mosaic Virus	Powdery Mildew	Monosporascus	Fusarium	Verticillium	Damping Off Complex	Acremonium root rot	Downy Mildew
AQ 10	AQ 10		P						
Azoxystrobin	Quadris		F/P						
Chloropicrin	Chloropicrin			G/E	G	G	G		
Chlorothalonil	Bravo		F/P						
Fludioxanil	Maxim			E					
Metam sodium	Vapam			E			E		
Mefenoxam	Ridomil Gold							F	G/E
Methyl Bromide	Methyl Bromide			G/E	G/E	G/E	G		
Sulfur	Sulfur		E						
Thiophanate methyl	Topsin-M		F/G					G	
Triflorystrobin	Flint		E						
Non-chemical Tools									
Models (i.e. disease forecasting)									
Irrigation management			G	E	G	F	E	E	
Weed control									
Resistant varieties			G						
Cover crops									
Adjusted planting date									
Post Harvest Crop Destruct				G		G			
Plant Nutrition									

Data based on collective field observations and experiments by growers, Pest Control Advisers, and University of California Cooperative Extension Farm Advisers.

Rating System
E = Excellent G = Good F=Fair P=Poor/None R=Known Resistance

Table 15

Efficacy of Nematode Management Tools Used in California Melons

Product	Trade Name	Root Knot Nematode
1,3-dichloropropene	Telone	E
Chloropicrin	Chloropicrin	G
Metam sodium	Vapam	E
Methyl Bromide	Methyl Bromide	E
Oxamyl	Vydate	G
Non-chemical Tools		
Fallow		P
Monitoring-soil samples		G
Cover crops		F
Soil/water management		P
Resistant varieties		P
Rotation		G
Soil Solarization		F
Plant Nutrition		F

Data based on collective field observations and experiments by growers, Pest Control Advisers, and University of California Cooperative Extension Farm Advisers.

Rating System
E = Excellent G = Good F=Fair P=Poor/None R=Known Resistance

Table 16

Efficacy of Weed Management Tools Used in California Melons											
Product	**Trade Name**	**Timing***	Nightshades	Nutsedge	Bindweed	Pigweeds	Johnsongrass	Volunteer cereals	Annual	Velvetleaf	Purslane
Bensulide	Prefar	LB	P	P	P	F			E	P	E
DCPA	Dacthal	LB	P	P	P	E			E		E
Ethalfluralin	Curbit	LB	G	P	P	F			E		G
Glyphosate	Roundup	PPF	E	F	G	E	F	E	E	E	E
Metam-Sodium	Vapam	PPF	G	F	F	G	F	E	E	E	E
Methyl Bromide	Methyl Bromide	PP	F	F	F	E			E		E
Oxyfluorfen	Goal	PP	E	P	F	E	P	P	F	E	E
Paraquat	Gramoxone	PPF	E	P	P	E	P	E	E	F	E
Sethoxydim	Poast	POE	P	P	P	P	E	E	E	P	P
Trifluralin	Treflan	PPI,LB	P	P	P	E	P	P	E	P	E
Non-chemical Tools											
Cultivation			G	P	F	G	P	G	G	F	G
Soil/Water management			F	P	P	F	P	P	F	P	F
Cover crops			P	P	P	P	P	P	P	P	P
Crop Rotation			G	G	G	G	F	F	F	G	G
Pre-irrigation			F	P	P	F	P	G	G	F	G
Subsurface drip irrigation			E	P	P	E	P	F	E	F	E
Hand weeding			E	P	F	E	P	G	G	G	G

Data based on collective field observations and experiments by growers, Pest Control Advisers, and University of California Cooperative Extension Farm Advisers.

Rating System
E = Excellent G = Good F=Fair P=Poor N=No Control R=Known Resistance

* Timing
LB= Layby PPF= Postplant foliar PP= Preplant PPI= Preplant Incorporated
POE= Postemergence

Table 17

Efficacy of Rodent & Other Vertebrate Controls in California Melons					
Technique	Crows	Voles	Gophers	Squirrels	Coyotes-Foxes
Prevention	N	F	N	N	N
Exclusion	N	F	N	N	N
Predators	N	F	P	N	N
Cultural Barriers	N	F	N	N	N
Trapping	N	G	F	N	F
Bait Stations	N	F	F	F-G	N
Lethal Control	L	P	F	G	L
Noise	F	N	N	N	N
Repellent	N	N	N	N	N
Mylar Strips	N	N	N	N	N

Data based on collective field observations by growers, Pest Control Advisers, and University of California Cooperative Extension Farm Advisers.

Rating System
E = Excellent G = Good F=Fair P=Poor N=No Control R=Known Resistance
L= Lethal Control is needed for these vertebrate pests.

Table 18

Total Pounds Active Ingredients of Insecticides Used in California Cantaloupes (1998-2001)

Product	Trade Name	1998	1999	2000	2001	4 Year Average
avermectin	Agri-Mek	122	135	93	109	115
azadirachtin	Neem seed oil	1	0	8	1	3
bifenthrin	Capture	534	453	672	1,024	671
Bacillus thuringiensis	Bt	1,987	1,166	1,402	2,229	1,696
carbaryl	Sevin	6,721	8,547	4,992	2,697	5,739
cyromazine	Trigard	11	0	25	101	34
diazinon	Diazinon	5,793	6,296	6,260	6,227	6,144
naled	Dibrom	291	689	65	0	261
dicofol	Kelthane	8,873	7,819	2,462	1,513	5,167
dimethoate	Dimethoate	465	769	118	38	348
endosulfan	Thiodan	12,244	10,631	11,639	11,800	11,579
esfenvalerate	Asana	381	218	162	134	224
imidachloprid	Admire	5,594	5,895	3,763	2,353	4,401
lindane	Isotox	6,435	117	5	58	1,654
malathion	Malathion	1,533	1,328	103	392	839
methamidiphos	Monitor	12	401	131	0	136
methomyl	Lannate	8,989	9,701	13,052	10,627	10,592
oxamyl	Vydate	3,847	5,372	2,945	750	3,229
permethrin	Pounce	1,031	470	502	665	667
potash soap	M-Pede	66	27	44	15	38
spinosad	Success	2	6	50	224	71

Source: California Department of Pesticide Regulation Pesticide Use Reports

Table 19

% Acres Treated With Insecticides: California Cantaloupes (1998-2001)

Product	Trade Name	1998	1999	2000	2001	4 Year Average
avermectin	Agri-Mek	20	22	22	27	23
azadirachtin	Neem seed oil	0	0	0	0.07	0
bifenthrin	Capture	8	7	13	20	12
Bt	Bacillus thuringiensis	33	22	28	44	32
carbaryl	Sevin	13	18	13	11	14
cyromazine	Trigard	0	0	0	2	0.5
diazinon	Diazinon	16	14	15	18	16
naled	Dibrom	0	0	0	0	1
dicofol	Kelthane	21	19	10	7	14
dimethoate	Dimethoate	2	3	1	0.3	2
endosulfan	Thiodan	15	15	22	20	18
esfenvalerate	Asana	12	6	7	6	8
imidachloprid	Admire	34	35	32	25	32
lindane	Isotox	9	7	1	2	5
malathion	Malathion	3	1	0	0.4	1
methomyl	Lannate	21	22	30	24	24
oxamyl	Vydate	4	7	6	2	5
permethrin	Pounce	9	5	7	10	8
potash soap	M-Pede	0	0	0	0.05	0
spinosad	Success	0	0	1	5	1.5

Source: California Department of Pesticide Regulation Pesticide Use Reports

Table 20

Total Pounds Active Ingredients of Herbicides Used In Cantaloupes (1998-2001)

Product	Trade Name	1998	1999	2000	2001	4 Year Average
bensulide	Prefar	15,846	17,326	9,569	12,281	13,757
ethalfluralin	Curbit	1,816	2,637	72	37	1,141
glyphosate	Roundup	8,193	4,078	6,431	4,239	5,735
metam sodium	Vapam	335,611	484,316	227,506	301,005	337,110
methyl bromide	Methyl bromide	155,355	135,794	94,509	30,628	104,072
oxyfluorofen	Goal	1,312	1,188	1,495	1,722	1,429
paraquat	Gramoxone	1,386	210	552	236	596
sethoxydim	Poast	470	534	77	183	316
trifluralin	Treflan	9,753	7,484	7,649	6,039	7,731

Source: California Department of Pesticide Regulation Pesticide Use Reports

Table 21

% Acres Treated With Herbicides: California Cantaloupes (1998-2001)

Product	Trade Name	1998	1999	2000	2001	4 Year Average
bensulide	Prefar	12	12	11	16	13
ethalfluralin	Curbit	5	6	6	6	6
glyphosate	Roundup	13	6	10	7	9
metam sodium	Vapam	5	7	5	8	6
methyl bromide	Methyl bromide	1	1	1	0.3	1
oxyfluorofen	Goal	7	4	7	14	8
paraquat	Gramoxone	2	0	2	0.6	1
sethoxydim	Poast	5	4	5	3	4
trifluralin	Treflan	21	16	21	17	19

Source: California Department of Pesticide Regulation Pesticide Use Reports

Table 22

Total Pounds Active Ingredients of Fungicides Used In Cantaloupes

(1998-2001)

Product	Trade Name	1998	1999	2000	2001	4 Year Average
azoxystrobin	Abound, Quadris	0	0	39	93	33
benomyl	Benlate	2,269	1,192	642	710	1,203
chloropicrin	Chloropicrin	8,682	46,134	6,105	31,236	23,039
chlorothalonil	Bravo	0	0	0	447	112
mancozeb	Dithane	170	75	774	383	351
mefenoxam	mefenoxam	935	1,300	900	577	928
methyl bromide	Methyl Bromide	155,355	135,794	94,509	30,628	104,072
myclobutanil	Rally	1,302	1,215	0	259	694
sulfur	Sulfur	562,107	480,066	242,758	162,170	361,775
triadimefon	Bayleton	923	168	0	7	275

Source: California Department of Pesticide Regulation Pesticide Use Reports

Table 23

% Acres Treated With Fungicides: California Cantaloupes (1998-2001)

Product	Trade Name	1998	1999	2000	2001	4 Year Average
azoxystrobin	Abound, Quadris	0	0	0	2	0.5
benomyl	Benlate	14	9	6	8	9
chloropicrin	Chloropicrin	0	1	0	1	0.5
chlorothalonil	Bravo	0	0	0	1	0.25
mancozeb	Dithane	0	0	1	0.4	0.35
methyl bromide	Methyl Bromide	1	1	1	0.3	0.8
myclobutanil	Rally	18	16	0	5	10
Sulfur	Sulfur	31	31	25	22	27
triadimefon	Bayleton	10	2	0	0.2	3

Source: California Department of Pesticide Regulation Pesticide Use Reports

Table 24

Total Pounds Active Ingredients of Nematicides Used In Cantaloupes (1998-2001)

Product	Trade Name	1998	1999	2000	2001	4 Year Average
1,3-dichloropropene	Telone	129,331	73,992	73,012	131,969	102,076
chloropicrin	Chloropicrin	8,682	46,134	6,105	31,236	23,039
metam sodium	Vapam	335,610	484,315	227,506	301,005	33,711
methyl bromide	Methyl Bromide	155,354	135,793	94,509	30,628	104,071
oxamyl	Vydate	3,847	5,372	2,945	750	3,229

Source: California Department of Pesticide Regulation Pesticide Use Reports

Table 25

% Acres Treated With Nematicides: California Cantaloupes (1998-2001)

Product	Trade Name	1998	1999	2000	2001	4 Year Average
1,3-dichloropropene	Telone	3	2	2	5	3
chloropicrin	Chloropicrin	0	1	0	1	0.5
metam sodium	Vapam	5	7	5	8	6
methyl bromide	Methyl Bromide	1	1	1	0.3	1
oxamyl	Vydate	4	7	6	2	5

Source: California Department of Pesticide Regulation Pesticide Use Reports

Table 26

Total Pounds Active Ingredients of Insecticides Used in California Mixed Melons* (1998-2001)

Product	Trade Name	1998	1999	2000	2001	4 Year Average
avermectin	Agri-Mek	49	24	39	27	35
azadirachtin	Neem seed oil	1	0	0	2	1
bifenthrin	Capture	853	945	1,509	1,488	1,199
Bt	Bacillus thuringiensis	685	304	701	904	649
carbaryl	Sevin	2,145	3,005	5,702	6,959	4,453
cyromazine	Trigard	0	0	0	0	0
diazinon	Diazinon	9,788	5,198	4,109	1,342	5,109
naled	Dibrom	0	111	0	10	30
dicofol	Kelthane	2,835	3,202	934	414	1,846
dimethoate	Dimethoate	1,178	1,946	2,205	1,533	1,716
endosulfan	Thiodan	2,409	1,741	2,783	2,952	2,471
esfenvalerate	Asana	403	219	262	61	236
imidachloprid	Admire	2,028	1,497	1,190	1,782	1,624
lindane	Isotox	13	0	0	0	3.5
malathion	Malathion	0	0	49	25	0
methomyl	Lannate	3,872	4,574	0	7,255	5,419
oxamyl	Vydate	294	1,088	1,751	1,587	1,180
permethrin	Pounce	612	264	351	531	440
potash soap	M-Pede	0	109	94	8	53
spinosad	Success	0	0	38	534	143

*Includes: cantaloupes, honeydews, casaba, Juan Canary, Santa Claus, piel de sapo and other unspecified melons that are not specifically identified in the Pesticide Use Reports and may be entered as just melons.

Source: California Department of Pesticide Regulation Pesticide Use Reports

Table 27

% Acres Treated With Insecticides: California Mixed Melons* (1998-2001)

Product	Trade Name	1998	1999	2000	2001	4 Year Average
avermectin	Agri-Mek	8	10	18	14	13
azadirachtin	Neem seed oil	0	0	0	1	0.25
bifenthrin	Capture	0	0	39	44	21
Bt	Bacillus thuringiensis	22	12	18	26	20
carbaryl	Sevin	16	19	24	35	24
cyromazine	Trigard	0	0	0	0	0
diazinon	Diazinon	27	22	21	10	20
naled	Dibrom	0	0	0	0.04	0
dicofol	Kelthane	17	20	7	6	13
dimethoate	Dimethoate	9	17	15	8	12
endosulfan	Thiodan	9	7	10	11	9
esfenvalerate	Asana	16	13	13	6	12
imidachloprid	Admire	22	24	22	32	25
lindane	Isotox	7	0	0	0.3	2
malathion	Malathion	0	0	0	0.02	0
methomyl	Lannate	17	20	0	33	18
oxamyl	Vydate	2	4	3	2.5	3
permethrin	Pounce	11	5	7	16	10
potash soap	M-Pede	0	0	0	0.04	0
spinosad	Success	0	0	1	25	7

*Includes: cantaloupes, honeydews, casaba, Juan Canary, Santa Claus, piel de sapo and other unspecified melons.

Source: California Department of Pesticide Regulation Pesticide Use Reports

Table 28

Total Pounds Active Ingredients of Herbicides Used In California Mixed Melons* (1998-2001)

Product	Trade Name	1998	1999	2000	2001	4 Year Average
bensulide	Prefar	2,994	4,709	972	2,436	2,778
ethalfluralin	Curbit	1,362	1,000	41	230	658
glyphosate	Roundup	3,635	2,200	2,650	755	2,310
metam sodium	Vapam	125,802	111,204	29,447	73,850	85,076
methyl bromide	Methyl bromide	42,336	1,793	0	0	11,032
oxyfluorofen	Goal	444	370	901	355	518
paraquat	Gramoxone	937	237	70	71	329
sethoxydim	Poast	107	255	8	90	115
trifluralin	Treflan	2,571	1,921	1,991	1,486	1,992

*Includes: cantaloupes, honeydews, casaba, Juan Canary, Santa Claus, piel de sapo and other unspecified melons.
Source: California Department of Pesticide Regulation Pesticide Use Reports

Table 29

% Acres Treated With Herbicides: California Mixed Melons* (1998-2001)

Product	Trade Name	1998	1999	2000	2001	4 Year Average
bensulide	Prefar	5	8	5	6	6
ethalfluralin	Curbit	6	6	3	4	5
glyphosate	Roundup	10	8	10	4	8
metam sodium	Vapam	6	7	4	6	6
methyl bromide	Methyl bromide	1	0	0	0	0.25
oxyfluorofen	Goal	7	4	8	6	6
paraquat	Gramoxone	4	1	0	0.4	1
sethoxydim	Poast	3	4	3	2	3
trifluralin	Treflan	15	9	11	8	11

*Includes: cantaloupes, honey dews, casaba, Juan Canary, Santa Claus, piel de sapo and other unspecified melons.

Source: California Department of Pesticide Regulation Pesticide Use Reports

Table 30

Total Pounds Active Ingredients of Fungicides Used In California Mixed Melons* (1998-2001)

Product	Trade Name	1998	1999	2000	2001	4 Year Average
azoxystrobin	Abound, Quadris	0	0	0	537	134
benomyl	Benlate	876	1,303	4	1,488	988
chloropicrin	Chloropicrin	140	6,831	0	705	1,954
chlorothalonil	Bravo	0	0	0	100	286
mancozeb	Dithane	663	0	0	2	201
mefenoxam	Ridomil Gold	27	153	21	98	75
methyl bromide	Methyl Bromide	42,336	1,793	0	0	11,032
metalaxyl	Ridomil	0	0	2	0	0.5
myclobutanil	Rally	630	565	0	3	300
sulfur	Sulfur	131,536	71,412	60,718	33,671	74,334
triadimefon	Bayleton	352	104	1	3	119

*Includes: cantaloupes, honey dews, casaba, Juan Canary, Santa Claus, piel de sapo and other unspecified melons.

Table 31

% Acres Treated With Fungicides: California Mixed Melons* (1998-2001)

Product	Trade Name	1998	1999	2000	2001	4 Year Average
azoxystrobin	Abound, Quadris	0	0	0	7	2
benomyl	Benlate	11	14	4	3	8
chloropicrin	Chloropicrin	0	0	0	0.07	0
chlorothalonil	Bravo	0	0	0	0.3	0
mancozeb	Dithane	1	0	0	0	0
methyl bromide	Methyl Bromide	1	0	0	0	0
metalaxyl	Ridomil	0	0	2	0	1
myclobutanil	Rally	17	17	0	0.1	9
Sulfur	Sulfur	16	14	12	11	13
triadimefon	Bayleton	7	2	1	0.1	2.5

*Includes: cantaloupes, honeydews, casaba, Juan Canary, Santa Claus, piel de sapo and other unspecified melons.

Source: California Department of Pesticide Regulation Pesticide Use Reports

Table 32

Total Pounds Active Ingredients of Nematicides Used In California Mixed Melons* (1998-2001)

Product	Trade Name	1998	1999	2000	2001	4 Year Average
1,3-dichloropropene	Telone	51,416	87,905	95,373	35,909	67,651
chloropicrin	Chloropicrin	140	6,831	140	705	1,954
metam sodium	Vapam	125,802	111,204	29,447	73,850	85,076
methyl bromide	Methyl Bromide	42,336	1,793	0	0	11,032
oxamyl	Vydate	294	1,088	1,751	1,587	1,180

*Includes: cantaloupes, honeydews, casaba, Juan Canary, Santa Claus, piel de sapo and other unspecified melons.

Source: California Department of Pesticide Regulation Pesticide Use Reports

Table 33

% Acres Treated With Nematicides: California Mixed Melons* (1998-2001)

Product	Trade Name	1998	1999	2000	2001	4 Year Average
1,3-dichloropropene	Telone	3	7	6	5	5
chloropicrin	Chloropicrin	0	0	0	0.07	0
metam sodium	Vapam	6	7	4	6	6
methyl bromide	Methyl Bromide	1	0	0	0	0.25
oxamyl	Vydate	2	4	3	2.5	3

*Includes: cantaloupes, honeydews, casaba, Juan Canary, Santa Claus, piel de sapo and other unspecified melons.

Source: California Department of Pesticide Regulation Pesticide Use Reports

Worker Protection Issues in California Melons

The following two tables provide estimates for various cultural practices and pest management activities and the potential for pesticide exposure.

Table 34

San Joaquin Valley: Cultural Activities and Potential Exposure

Activity	Average Times per crop	Minimum to Maximum times	Average acres per day	Average acres per hour	Potential Exposure
Listing/Bed Preparation	6	4-8	50	5	0
Planting	1	1-2	60	6	+
Cap Removal	1	1-2	60	6	0
Pre-thinning Cultivation	2	1-3	40	4	0
Thinning	1	1	40	4	0/+
Fertilization	2	2-3	50	5	+
Cultivation	3	1-4	40	4	+
Pollination	1	1	20	2	++
Irrigation	4	2-5	40	4	+
Harvest	12	9-20	100	10	+
Discing after harvest	2	2-3	50	5	0

Table 35

San Joaquin Valley: Plant and Pest Monitoring Activities and Potential Exposure

Activity	Average Times per crop	Minimum to Maximum times	Average acres per day	Average acres per hour	Potential Exposure
Soil Sampling	1	1	100	10	0
Insect Scouting	15	14-20	80	8	+
Disease Scouting	15	14-20	80	8	+
Petiole Sampling	3	1-4	80	8	+
Irrigation Scheduling	5	5-10	80	8	+
Insecticide Application	3	1-4	40	4	++
Herbicide Application	2	2-3	50	6	+
Fungicide Application	1	1-2	30	3	++

0 = No exposure **+ = Minimal exposure potential**

++ = Moderate exposure potential **+++ = High exposure potential**

Members of the California Melon Work Group in Attendance – January 7-8, 2002

Growers, Packers, and Shippers

1. George Delgado, melon grower, Pest Control Adviser, Firebaugh, CA
2. Bob Frommelt, melon grower/shipper, CMRB representative, Yolo, CA
3. Vence Orlando, melon grower/shipper, CMRB representative, Los Banos, CA
4. Milas Russell, Jr., melon grower/shipper, CMRB representative, Brawley, CA

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5. Lori Berger, Director of Technical Affairs, CA Minor Crops Council, Visalia, CA
6. John LeBoeuf, CMRB Pest Control Advisers
7. Isaac Castaneda, Woodland, CA
8. Chad Elliott, Ehrenberg, AZ
9. Pat Romero, Ceres, CA
10. Rick Sandberg, Fresno, CA
11. Mary Wilson, Palm Desert, CA
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Land Grant University Research and Extension Personnel

13. Carl Bell, U.C.C.E. Regional Adviser, Weed Management Specialist, San Diego, CA
14. Milt McGiffen, Extension Vegetable Specialist, Weed Management, U.C. Riverside
15. John Palumbo, Research Entomologist, U. of Arizona, Yuma
16. Antoon Ploeg, Extension Specialist, Nematology Researcher, U.C. Riverside
17. Mike Stanghellini, Plant Pathology Researcher, U.C. Riverside
18. Tom Turini, U.C.C.E. Farm Adviser, Plant Pathology, Holtville, CA
19. Kai Umeda, U. of Arizona Cooperative Extension Agent, Maricopa County

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20. Ann Thrupp, EPA Region 9 Agricultural Initiative, San Francisco, CA

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21. Linda Herbst, Asst. Director, California Pest Management Center, U.C. Davis
22. Rick Melnicoe, Director of California Pest Management Center, U.C. Davis

Other Industry Representatives

23. Orlando Chaun, Senior Supervisor, Sheriff's Department, Irvine, CA
24. Bernard Olsen, Technical Sales Representative, Eden BioScience, Fallbrook, CA
25. Jim Thomas, Correctional Farm Supervisor, Sheriff's Department, Irvine, CA

Other Invited Guests (not in Attendance)

1. Pat Cimino, USEPA Minor Crops Advisor, Washington, D.C.
2. Kathy Davis, B.E.A.D. Representative, US-EPA, Washington, DC
3. Julie Fairfax, Pesticide Environmental Stewardship Program, EPA, Washington, D.C.
4. Becky Sisco, IR-4, U.C. Davis
5. Wilfred Burr, USDA - ARS-Office of Pest Management Policy, Washington, D.C.

Other Members of the Melon Work Group in Attendance – January 6, 2003

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2. Ken Melban, CMRB representative
3. Joe Danna, Danna & Danna
4. Steve Danna, Danna & Danna
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2. John Perry, Bayer CropScience, Kingsburg, CA
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