COOPERATIVE EXTENSION AZ1028

Melon Insect Pest Management in Arizona

The University of Arizona • College of Agriculture • Tucson, Arizona 85721 6/98

IPM Series • Number 11

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Melon production in the southwestern United States occurs primarily in the desert growing areas of Arizona, and southern California. Cantaloupes, *Cucumis melo,* and watermelons, *Citrullus lanatas,* are the predominant melon types cultivated, but Persian, honeydew, crenshaw, and casaba melons, *Cucumis melo,* are also grown on a limited scale. These crops require irrigation throughout their production cycle and are planted during two distinctive growing seasons. Fall melons are typically planted from July-September, whereas spring melons are planted from January-March. Melons reach harvest maturity in 85-110 days depending upon melon type, variety, planting date and seasonal temperatures.

Although melons can be produced any time during the year in the lower desert, the growing seasons are largely determined by the domestic melon market. Market prices are usually highest during the late spring and fall when melon availability from other growing locations is limited. Furthermore, prices can vary considerably throughout the growing season, depending of melon quality, demand and availability. Fruit quality, both edible and cosmetic, can significantly influence the price a grower will receive for his crop. Because of the high growing costs required to produce melons, growers intensively manage their crops for the highest possible yield and free of insect damage.

Melons in Arizona are grown in very diverse cropping systems, where a variety of vegetable, agronomic and seed crops are cultivated concurrently throughout the year. Numerous insect species can be found on melon plants, but only a few have been determined to be economically important. Most of the key insect pests of melons are polyphagous (feed on multiple plants) and migrate into melons from surrounding crops and weed hosts. Consequently, cultural management practices can have a measurable impact on pest population dynamics, but control with insecticides is often necessary to prevent reductions in yield and quality. Discussed below are descriptions of several key insects that cause economic damage to melons and the tactics commonly used to manage infesting populations.

I. Ground Dwelling Pests

Field crickets, *Gryllus* spp.,

Description: Crickets are annual pests in fall melons, especially where over-head sprinkler irrigation is being used. The adults are black or brown and are 1.5-2.5 cm in length. Eggs are laid in damp soil both within and outside of cultivated fields. Adults and nymphs are usually present throughout the season, but appear to be most harmful during stand establishment of direct seeded melon crops.

Damage: Crickets will reduce crop stands by eating the newly emerged seedlings. When they occur in large numbers, they can quickly destroy most of a field. Problems usually occur in fields planted adjacent to cotton or sudangrass in August and September, where large numbers are capable of migrating to seedling cantaloupes and watermelons.

Management and Control: Most damage occurs at night and crickets hide during the day in soil cracks, ditches, weeds, and under irrigation pipes. It is difficult to monitor for cricket abundance. Scout the field by looking under the sprinkler pipe for cricket adults. In most case, cricket activity can be determined by the visual estimate of damaged seedlings. Immediate postharvest discing of previous crops aids in area-wide cultural control of crickets. Direct seeded melons planted in close proximity to cotton or sudangrass should be considered high risk fields and damage should probably be treated as soon as seedlings begin emerging. Insecticide-treated baits are available that can be placed around field edges to control migrating populations. Additionally, insecticides can be applied through the sprinkler system during plant emergence.

Cutworms, *Agrotis ipsilon, Peridroma saucia*, and *Feltis subterranea*

Description: All melons are susceptible to attack by several species of cutworm larvae. Cutworm adults are medium-sized moths, usually brown or gray with irregular spots and lighter hind wings. Females lay hundreds of eggs singly or in clusters (depending on species) on leaves or stems close to the soil. After hatching, young larvae feed on leaf surfaces for a short period, but older larvae drop to the ground, tunnel into

the soil and emerge at night to feed. Mature larvae are robust, 2-2.5 cm long with mottled brown or gray skin. Larvae tend to curl up into a C-shape when they are disturbed.

Damage: Young plants are often damaged or killed by cutworms. Cutworms typically cut off seedlings or young plants at or just below ground level. Losses can be especially serious in fields that have an abundance of organic matter, which attracts moths to deposit eggs. Larvae usually hide in the soil under debris, or under clods during the day and come out at night to feed. Some species can reduce the cosmetic appearance of cantaloupes by scarring the undersides of mature melons.

Management and Control: Cultural control methods can help minimize cutworm damage. Areas with weeds, or crop residue or areas located near alfalfa fields often have high populations. Pay close attention to fields that follow small grains, corn or alfalfa. Eliminate weeds from field margins and plow fields at least 2 weeks before planting. Destroy plant residue from previous crops and avoid planting fields coming directly out of pasture. Several natural enemies attack cutworms but none are effective enough to provide reliable control. After the crop emerges, monitor for cutworm injury by walking the field when plants are in the seedling stage. Check for wilted plants with complete or partially severed stems. Damage is often more serious on the edges of fields, but stand losses can occur in clumped patterns throughout the field. If large areas are infested, treat with insecticides when problems are first observed before stands are severely reduced or fruit is damaged.

Seedcorn maggot, *Delia platura*

Description: The seedcorn maggot is a white, legless larva of a small light gray fly that attacks the planted seed of cantaloupes and watermelons during the spring. They can be particularly serious if there is a cold period that prevents quick germination of the seed. Maggots may overwinter as a larvae in the soil or hatch from eggs laid in the spring. There usually have three-four generations per year, but only the first is economically significant.

Damage: The maggot attacks germinating seeds or transplants, but may be a severe pest in the early spring when the soil is cool. The maggots bore into seeds or into the developing hypocotyl of developing plants. Seedlings with maggots will wilt and die within a few days . Under favorable growing conditions for melons (80-85° F), little damage is likely to occur. The conditions that favor seed maggot infestations include high levels of decaying organic matter and cool wet weather. The flies can also be attracted to the commercially prepared growing medium used to start melon transplants in the greenhouse.

Management and Control: Fields with heavy-textured soil usually experience the worst problems with seedcorn maggots. Incorporation of previous crop residues by discing or plowing well in advance of planting helps to reduce the attractiveness of the field to ovipositing adults. Avoid direct seeding or transplanting melons after root crops, cole crops or fall tomatoes. Rapid seed germination greatly reduces the risk of infestation. Late season planting may avoid the early season infestation of this pest. A preventative seed treatment or transplant drench is the best method of control when conditions are ideal for maggot infestation.

Darkling Beetles, *Blaspstinus* spp.

Description: Darkling beetle adults chew off seedlings, feed on foliage, and occasionally on fruit that is on the soil. The adults are from 3-6 mm long and are black or brown. Darkling beetles, which are in the family Tenebrionidae, can be easily confused with predaceous ground beetles (family Carabidae), which prey on various soil insects. The two beetles can generally be distinguished by the carabids lack of clubbed antennae. Darkling beetles are most active at night but can be spotted moving on the ground during the day. They generally stay hidden in the soil or within field debris. Larvae are cylindrical soil-inhabiting worms that are yellow and range from 1-8 mm in length,. They are often referred to as false wireworms, and are not considered economically important.

Damage: Darkling beetles are generally not a problem unless large populations move into a field when plants are emerging. They usually invade fields from weedy areas or crops such as cotton and alfalfa, so damage is often first observed on field edges. Seedling plants may be girdled or cut off at the soil surface. Once the plants have 5-6 leaves, the beetles are usually not a problem. As the season progresses, feeding can occur on flowers, on the undersides of leaves and on the netting of mature melons. Under moist soil conditions, they can also bore into fruit where it rests on the seed bed.

Management and Control: Several cultural practices can help reduce potential problems associated with darkling beetles. Maintain fields and ditches free of weeds. Water barriers placed around the field can aid in reducing migrating populations. Reducing organic matter in the soil by fallowing or deep-plowing will minimize beetle reproduction. When beetles are observed migrating into melons from surrounding fields, a bait placed around the edges of the field will usually provide adequate control. Treat fields with insecticides whenever beetles are readily observed feeding on plants, flowers or fruit.

II. Foliar Feeding Pests

Leafminers, *Liriomyza sativae* and *Liriomyza trifolii*

Description: *Liriomyza* leafminers can readily cause economic damage to melon plants, particularly in fall plantings. The principal leafminer species in Arizona include *L. trifolii* and *L. sativae*. The leafminer adults are small, shiny black and yellow flies with a bright yellow triangular spot on the upper thorax between the wings. Subtle differences in color exist between adult *L. sativae* and *L. trifolii*. Females puncture young leaves and oviposit eggs within the leaf. Numerous punctures are made, but only a small percentage contain eggs. Both male and female flies often feed at puncture sites. After a few days, larvae hatch and begin feeding on plant mesophyll tissue just below the upper surface of the leaf. Larvae emerge from the mines after completing three instars, drop to the soil and pupate. Pupation and larval development require about the same amount of time to complete, both of which are determined by temperatures. The optimal temperature for development is about 85-90°F and development ceases below 50°F. The entire life cycle can be completed in less than 3 weeks under ideal conditions. Several generations may be produced during each growing season in Arizona.

Damage: Mining of leaves by the larvae is the principal cause of plant injury. Larvae mine between upper and lower leaf surfaces creating winding tunnels that are initially small and narrow, but increase in size as the larvae grow. These mines can cause direct injury to seedling plants by removing chlorophyl and reducing the plants photosynthetic capacity. Mines and feeding punctures also produce an entrance for pathogenic organisms. Excessive leaf mining in older plants can cause leaves to dry, resulting in sunburning of fruit and reduction in yield and quality. In severe infestations, leafmining may cause plant death. Damage to mature plants can occur when attempting to hold the crop longer for a second or third harvest.

Management and Control: Early season leafminer infestations are common, but in most cases are controlled by numerous species of parasitic wasps. The absence of these natural enemies can result in leafminer outbreaks. Leafminers are seldom damaging to spring melons unless temperatures are unusually high. Leafminers in fall melons can be particularly damaging in fields planted near cotton or alfalfa because adults migrate onto emerging melon seedlings in the absence of their natural enemies. Secondary leafminer outbreaks can occur from the destruction of parasitoids by frequent insecticide applications used to control other pests. Thus, evaluation of leafminer parasitism is an important criterion to determine the need for control. Young seedling plants should be monitored regularly for the presence of adults, larvae and parasitized mines. Mining will initially occur on the cotyledons and first true leaves. Yellow sticky traps can assist in determining when early migrations take place, and also help in determining species composition. It is important to identify the predominant leafminer species because *L. trifolii* is much harder to control with insecticides than *L. sativae*. If populations of adults and larvae build to high levels when seedlings have 4-5 leaves and parasitism is low, insecticide treatments may be necessary to prevent economic damage. For older plants, control decisions should be based on the number of unparasitized leafminers. In watermelons, chemical treatment is recommended if an average of 15 to 20 unparasitized larvae per leaf are found. For cantaloupes, insecticide treatment is recommended if an average of 5 to 10 unparasitized larvae per leaf are found. Cultural management can help reduce potential problems with leafminers. Avoid planting adjacent to cotton and alfalfa whenever possible. Deep plowing after harvesting crops aids in reducing leafminer populations. Row covers applied at planting and removed at first bloom have been shown to exclude leafminer adults. Melons plants that are not stressed for moisture or by other environmental factors can often better tolerate leafminer injury.

Beet Armyworm, *Spodoptera exigua*

Description: Beet armyworm can cause economic damage to spring and fall watermelons, honeydews and cantaloupes. Eggs are light green in color and are laid in irregular clumps or masses, usually covered with hairlike scales.Young larvae will feed in groups and spin webs over the underside of the foliage where they are feeding. Larvae vary in color, but are usually dull green with light colored stripes down the back and a broader stripe along each side. Beet armyworms usually have a dark spot on the side of the body above the second true leg. Mature larvae vary in size but are usually about 3-4 cm. in length. The moth has grayish brown forewings with a pale spot in the mid-front margin, and the hindwings are white with a dark anterior margin. Larval development varies with temperature but normally requires about 3 weeks during fall crops.

Damage: The beet armyworm is primarily a foliage feeder, but causes cosmetic damage to watermelons by attacking immature fruit. The injury caused by fruit feeding is superficial and little loss would result if not for the cosmetic blemishes left on mature melons and fruit rot that may occur from secondary pathogenic organisms that enter the wounds. The larvae will occasionally develop inside the fruit, causing abnormal development and abortion of the fruit.

Control and Management: Check surrounding vegetation for the presence of beet amyworm larvae. Sanitation along field borders is important as beet armyworms often migrate from weedy field edges into newly planted fields. Populations of this pest also tend to build up in cotton and alfalfa during the summer. There are natural enemies and viral pathogens that will attack populations of armyworm larvae, but may not always provide adequate and reliable control. Monitor fields by checking developing fruit for larvae and feeding damage. Treat with insecticides if feeding is observed on the fruit. To conserve natural enemies important for the natural control of leafminers, consider using *Bacillus thuringiensis* sprays if small larvae (neonate and 1st instar) are present.

Cabbage Looper, *Trichoplusia ni*

Description: The cabbage looper can be a destructive pest of all melon crops. Populations can be especially prevalent in the fall, when newly-planted seedlings are emerging. Cabbage looper moths lay single, dome-shaped eggs on the underside of older leaves. The larvae are light green in color and have a distinctive white stripe along each side of the body. The larvae have two sets of legs in the front of the body and three sets of fatter, unjointed prolegs at the rear causing them to move in a "looping" manner, arching the middle portion of the body as they move forward. Cabbage looper pupae appear as greenish to brown pupa wrapped in a delicate white cocoon of fine threads usually attached to the underside of the leaf. The moth is mottled brown in color, and has a small silvery spot (sometimes a figure 8) near the middle of its front wing.

Damage: Loopers injure plants by feeding primarily on the underside of leaves, leaving ragged holes. In fall crops, high populations can chew seedlings severely enough to reduce stands or delay crop growth and maturation. In cantaloupes, larvae may move to the mature fruit and feed on the netted surface causing cosmetic blemishes. Watermelons are damaged by larval feeding on small developing fruit and the rind of more mature melons, leaving cosmetic blemishes similar to that caused by beet armyworm.

Management and Control: The cabbage looper has many natural enemies that will keep larval populations below damaging levels unless disrupted by insecticide applications. Several parasitic wasps (both egg and larval parasitoids) are important natural control agents. The tachinid fly, *Voria ruralis*, also attacks developing loopers. Under ideal environmental conditions, a nuclear polyhedrosis virus that occurs naturally in fields may control looper populations. Cultural control tactics employed for beet armyworm are also recommended for management of cabbage looper. Monitor for larvae and eggs by looking on the underside of leaves. Insecticide treatments are recommended when larvae feeding on the leaves can easily be found. In addition, adult flights monitored with pheromone traps and observations of egg deposition can be used to time treatments. Cabbage loopers are particularly susceptible to *Bacillus thuringiensis*, and should be applied when eggs start to hatch and larvae are small.

III. Sucking Pests

Two-spotted Spider Mite, *Tetranychus* spp.

Description: Spider mites are widespread on melon crops throughout the southwestern U.S, but only occasionally cause significant damage. Spider mites are very small and are difficult to see with the naked eye. Adults are about 0.45 mm long, have eight legs and an oval body. Tiny spherical eggs may be present as well as webbing. Spider mites develop numerous generations throughout each melon growing season. Under optimal conditions of high temperatures and low humidity, mites can complete their life cycle in five to seven days.

Damage: Spider mites injure melons by puncturing the surface cells on the underside of leaves where they feed. This results in the destruction of chlorophyl and reduction in photosynthetic activity. Injured leaves become pale, stippled and can dry up and die under heavy infestations. Injury often is not noticed until reddish brown patches of affected plants appear in the field. Injury is most common in hot, dry weather from late spring to early fall when temperatures are favorable for rapid development. Light infestations can be tolerated, but severe injury can result in lowered yields and reduced fruit quality.

Management and Control: Spider mites feed on a large number of crops and weeds, and will overwinter in soil and debris on the ground. Infestations in melons often begin with adults carried into fields by wind from adjacent crops. Because dust favors spider mite populations, minimize dust by watering field roadways. Several natural enemies (including predatory mites and thrips, minute pirate bugs and lacewings) play an important role in regulating mite populations below economic injury levels. Predator populations should be encouraged by limiting chemical rates and numbers of applications for other insect pest. Good irrigation and fertilization management increases plant tolerance to mites. No economic thresholds have been established for spider mites. However, treatment with an acaricide is recommended when webbing occurs before vines reach 14 inches in length and predatory mites and thrips are absent. Spider mites inhabit the undersurface of leaves and thorough spray coverage is important.

Silverleaf Whitefly, *Bemisia argentifolii*

Description: In the past few years, the silverleaf has shifted from a position as a secondary pest (virus vector) to being the primary pest in fall vegetables, melons and cotton in the southwest. This shift in pest status is thought to have occurred due to the development of a new strain of the sweetpotato whitefly (B-strain), or as many now believe, the emergence of the species, silverleaf whitefly. The adult is a small insect, about 1-1.5 mm long with the body and wings covered with a whitish powdery wax. Eggs are minute (0.2 mm), oval, yellow and attached to leaf tissue. Near hatching, the egg will darken in color. Adults and eggs are most prevalent on the lower surface of younger leaves and the scalelike nymphs on older leaves. Crawlers (first instar nymphs) are yellowish in color and are oval and flattened in appearance. They are 0.2 to 0.3 mm in length, and will move about until they locate an acceptable feeding site (a minor vein). Next they become immobile and remain so through four nymphal instars. Late third and fourth instar nymphs have distinctive red eye spots and are termed red-eyed nymphs. At the end of the fourth instar they enter the pupal stage. Their pupal cases are dome shaped and oval in their outline, and are 0.7 to 0.8 mm in length. Whiteflies complete 2-3 generations in spring melons and can complete their life cycle in a short as 16 days during fall growing conditions.

Damage: Although the sweetpotato whitefly has a wide host range, one of its most preferred hosts is cantaloupes. It has become a serious pest on melons because of its high reproductive capability, wide host range, high rate of feeding, exudation of sticky honeydew and habit of feeding on the undersides of leaves where they are protected from insecticide sprays. Adults and nymphs feed on melon leaves by inserting their tubular mouthparts into vascular tissue and extracting plant assimilates (carbohydrates and amino acids). They also injure developing plants by destroying chlorophyll and reducing the plants photosynthetic activity. Heavy populations on young plants can cause desiccation of leaves and plant death. Whitefly populations cause serious economic damage to melons crops by reducing fruit quantity and size. Fruit quality is also impacted by the lowering of soluble sugars in the fruit and by the contamination of fruit with honeydew which gives rise to sooty mold fungus.

Management and Control: Whitefly populations will build in cotton and alfalfa, so growers should pay particular attention to melons planted downwind or adjacent to these fields. For spring melons, termination of winter vegetable crops immediately following harvest is important in the area wide management of whiteflies. Although several parasitic wasps (*Encarsia* and *Eretmocerus* spp.) are effective parasitoids of sweetpotato whitefly, populations of these natural enemies are not capable of naturally controlling whitefly populations under southwest growing conditions. Thus, melons planted in high risk situations (late spring and fall plantings) should be treated prophylactically with a soil-applied systemic insecticide such as imidacloprid. Melons planted in January and February when temperatures are cool and when there is no significant source of whiteflies in a one mile radius should be treated as needed with foliar adulticides.

Whiteflies are best controlled by preventing immature populations from colonizing plants; do not allow adult populations to build up and deposit large numbers of eggs. If available, a systemic insecticide should be used at planting to protect emerging seedlings from colonizing adult populations. Subsequently, melons should be monitored as soon as the plants emerge. Sample for whiteflies early in the morning when the adults are sedentary. A presence-absence sampling plan has been developed for whiteflies on cantaloupes. To estimate whitefly abundance, randomly sample 50 leaves in each field. When greater than 50 percent of the leaves are infested with one or more adults then an insecticide treatment should be applied to prevent economic damage. Good spray coverage is essential for control. If possible use ground application equipment that delivers spray at high pressure and volumes.

Green Peach Aphid, *Myzus persicae*

Description: The green peach aphid occurs throughout the Southwest and has a wide host range. The green peach aphid is generally considered to be a pest in spring melons. The winged adult stage is of primary concern because of their ability vector viral diseases. Winged green peach aphid adults have a black / brown head and thorax. Their abdomen is light green or red with a black / brown mottling. At the base of each antenna of many aphids is a small bump called a tubercle. In green peach aphids these tubercles are pronounced and converging inwardly, while similar species tubercles are less pronounced or diverging. Wingless adults are light green or red with the same antennal bumps. Nymphs appear as smaller versions of the wingless adults. The life cycle of the green peach aphid is typical for aphids. In southern climates it reproduces asexually. In response to crowding by other aphids or declining host plant quality, migratory (winged) forms are produced that move to new hosts (weeds or crops). This ordinarily occurs in the early spring.

Damage: The major injury from green peach aphid is a result from virus transmission. Watermelon mosaic virus, zucchini yellow mosaic virus, and papaya ringspot virus are transmitted to melons primarily by the green peach aphid. The spread of virus to a melon

field is due to the movement of winged forms during the spring. Infected aphids move into spring melons fields in large numbers from surrounding crops and weed hosts. Within field spread occurs as aphids feed and move from one plant to another. The incidence of these viruses causes significant reduction in melon yields and heavy virus infection can result in total yield loss. Incidence of green peach aphid and its associated viruses are rare in fall planted melons. Severe colonization of green peach aphids can reduce plant growth due to removal of plant fluids, but this aphid is rarely numerous enough to cause economic injury.

Management and Control: Green peach aphids are often most numerous in fields containing weedy mustards and members of the goosefoot family. Control of these weeds may help prevent buildup of green peach aphid. Naturally-occurring populations of predators, parasitoids and fungal pathogens may provide effective control in early spring. Green peach aphids can be excluded from plants by placing row covers over the seed bed following planting until first bloom. Reflective mulches have also been shown to be effective in repelling aphids from plants. Because of the short feeding time required for these aphids to transmit viruses, insecticide treatments will not prevent virus introduction, but may reduce the spread of the virus within the field. Monitor for aphid flight activity and species composition using yellow sticky traps. Melons planted in January and February prior to peak aphid flight should be prophylactically treated with a soil-applied systemic insecticide at planting. The decision to treat for aphids should be based on the presence of winged forms in the field.

Melon Aphid, *Aphis gossypii*

Description: The melon, aphid, also called the cotton aphid, is a small dark species that ranges in color from yellow to black. The winged adults are about 1.5 mm in length and not quite as robust as the wingless mature form. The melon aphid develops in aggregated colonies and is distributed primarily on the underside of leaves. This aphid species appears in high numbers in the cooler spring months, but unlike the green peach aphid, melon aphid populations can be found infesting melons when temperatures are warm. They reproduce parthenogenically and develop at a very high rate under ideal growing conditions. They can also be serious problems on fall melons. Melon aphid has an extensive host range including, cotton, citrus, and many summer annual weeds.

Damage: Similar to green peach aphids, the melon aphid is a known vector of several viruses. However, they can also cause injury to melons through their feeding. They can be a major problem on young plants where they cluster on the terminal growing points of the developing vines, distorting and curling the leaves, and producing large amounts of honeydew. Feeding damage can lead to loss in plant vigor, reduced growth rate and plant death. Melons aphids will injure all melon types grown in the southwest.

Management and Control: The same cultural control tactics used for green peach aphid should be employed for management of melon aphid populations. Numerous naturally-occurring predators and parasitoids will attack melon aphids and are capable of keeping them under control if not disrupted by insecticide applications. Melon aphid is very difficult to control with insecticides. No thresholds have been established for timing treatments, but applications should be made if large numbers of aphids build up early in the season and natural enemies are absent. Early treatment does not prevent virus transmission, but may reduce within-field spread of the virus.

IV. Fruit Feeders

There are several insect species discussed in the above sections that damage immature and mature melon fruit. Species that feed on the fruit such as cutworms, darkling beetles, cabbage loopers and beet armyworms are important because of the cosmetic blemishes and fruit rot that their feeding causes. Although sucking insects such as whiteflies and aphids don't actually feed on the fruit, the exudation of honeydew on melons can contaminate and reduce the quality of otherwise marketable melons.

V. Pollination

Because cantaloupes and watermelons are monecious, pollination by honey bees, *Apis mellifera*, is essential for the production of high quality melons. Colonies of honey bees need to be placed in or around fields to ensure pollen transfer from staminate to pistillate flowers. Insufficient pollination will result in misshapen melons. To produce high quality melons, it is recommended that 2-3 hives per acre be placed in each field. Consequently, extreme care must be taken with pesticides to prevent the destruction of honey bees. Some insecticides used in melon pest management programs are highly toxic to these pollinators. Bee kills are likely to occur when crops are treated with insecticides during the blooming period. Losses can result from direct sprays on bees, drift onto hives or adjacent fields, and by contamination of drinking water, pollen or nectar. The following practices are very important in planning pesticide applications. If possible, avoid making pesticide applications when melons are in bloom. If applications are necessary during bloom, apply the pesticide that is least toxic to bees and will still control the target pest. Spray during the evening or early morning when the bees are not actively working in the field. Finally, it is very important to notify beekeepers before applications are made. The advance notice allows beekeepers to take necessary steps to move or protect their hives.

Acknowledgments

The following individuals are recognized and appreciated for their suggestions and comments during the production of this publication: Todd Hannan (Barkley Co. of Arizona), Scott Tollefson (Del Monte, Inc.), Rick Gibson (Pinal County Coop. Extn.), Tim Knowles (La Paz County Coop. Extn), Mark Wilcox (Yuma County Coop. Extn.), Kai Umeda (Maricopa County Coop. Extn), and Eric Natwick (Imperial Valley Coop. Extn).

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