



Specialty Melon Production for Small and Direct-Market Growers

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This publication provides an overview of production and marketing of numerous different species and varieties of specialty melons (Family: Cucurbitaceae). It addresses production considerations including seed sources, planting needs, soil preparation, and insect pest and disease control. It also discusses marketing outlets for producers to sell their melons and summarizes results of current melon research. A resource list details sources for more information, seeds, and supplies useful for melon growing.

Introduction

Specialty melons are members of the genus *Cucumis*, or a few select members of the cucurbit family, whose fruits may be large, have unique flavors, and command a high price in the marketplace (Hill, 1996). These melons offer an alternative to the run-of-the-mill 'market variety' melons commonly available. Common melons were selected for their ability to be shipped long distances (thus 'Western Shipper' types), while specialty melons were selected mainly for flavor. This means they have a shorter shelf life but can command premium prices.

Growing specialty melons offers a producer the potential for more profit using less space and fewer resources. These melons are mostly heirloom varieties that are amenable to organic production using fewer inputs and no synthetic chemicals. However, the trade-off for reduced inputs and higher profits is a significant increase in labor.

Melons belong to the cucurbit family (Cucurbitaceae), which also includes cucumbers and squash. Although melons have been found in ancient China, Egypt, and Iran, their center of diversity is Africa, with secondary centers in China and India. Wild melons have been reported in desert and savanna zones of Africa, the Arabian Peninsula, southwestern Asia, and Australia (Kirkbride,



Momordica, or Bittermelon, is an alternative crop for growers wishing to diversify their vegetable operations. Only the red arils surrounding the seeds of the ripened fruit are sweet. The rest of the plant is, as its name implies, very bitter. Photo: Balaram Mahalder

1993). Melons were cultivated by the Romans and it's believed European varieties were diffused through conquest (Sauer, 1993).

The most popular melon types include watermelon, cantaloupe, and honeydew.

The scientific name for both cantaloupes (musk-melons) and many specialty melons is *Cucumis melo*. Of the seven variants of *Cucumis melo* (conomon, cantalupensis, chito, dudaim, flexuosus, inodorus, momorida, and reticulatus), only two are commercially grown in the United States: reticulatus and inodorus. Generally, in North America, any round melon with firm, orange flesh and moderately sweet taste is called

a cantaloupe, although this is a misnomer. True cantaloupes (*Cucumis melo cantaloupen-sis*) are a rough, warty and/or sutured fruit, like Charentais melons, which are popular in Europe but only grown for the specialty market in the United States. Muskmelons include smooth-skinned varieties such as honeydew, Crenshaw, and Casaba, as well as netted-rind fruits such as Persian melon and Santa Claus or Christmas melon. These inodorus variants



This cantaloupe cross-section shows the characteristic structure of fruit of the Cucurbits, which is three carpels within one locule. Photo: Dr. John Jifon, TAMU

lack the aromatic or musky odor of the reticulatus group, the characteristically pleasant scent for which the muskmelon is named. Muskmelon flesh ranges from green to dark orange.

Cantaloupes and specialty melons have maintained a substantial market share during the past 10 years across the United States, primarily due to consistently high sugars. In addition, consumer interest in different textures and flavors in melons has driven demand for these high-value crops. Seed availability has also improved with better adapted cultivars released in the past few years (Hornick, 2012).

Leading melon-producing states include California, Arizona, Texas, Georgia, and Florida (NASS, 2014). Specialty melons, such as Tuscan types and other cantaloupes with green or orange flesh color, are very popular in the United States. These types of melons are often consumed as fruit salads, breakfast foods, desserts, and snacks.

Cultural Information

Understanding how melons grow is key to successful production. Soil temperature should be at least 60°F for germination. Plant seed about ½ to ¾ inches deep. About one pound of seed (~15,000 seeds/pound) will be required per acre. For direct seeding, plant six seeds per hill with hills four to six feet apart, or one foot apart in rows five feet apart to allow room for vines to extend. Thin to two to three plants per hill. Beds should be six to eight inches high to facilitate drainage. They

are usually planted on hills rather than rows or in ‘watermelon rows’ (six to eight feet wide with 5- to 6-foot spacing within row) for larger cultivation areas.

Commercial growers prefer hybrid seed because of higher yields and consistent quality. Many organic farmers prefer heirloom seed for better fruit flavor. To find organic seed suppliers, listed by state, use the ATTRA online database *Directory of Organic Seed Suppliers* at https://attra.ncat.org/attra-pub/organic_seed/.

Melons prefer well-drained, upland, silty or sandy-loam soils with a pH between 6.0 and 6.5. Melons planted into acidic soils (pH less than 6.0) will have yellowed foliage and produce fewer perfect flowers. Alkaline soils should be amended with sulfur to bring pH to at least 7. Sandy soil is preferred, but clay soil with organic matter well worked throughout the hill to a depth of 12 to 18 inches should suffice. Melons appreciate soil amended with generous amounts of well-rotted manure compost.

Cantaloupes and specialty melons grow as prostrate vines that scramble over the ground in many directions. This growth habit can make weeding difficult in later stages of development because it’s challenging to remove the weeds without damaging the vines. Sometimes trellises are used in melon production for this reason and others (i.e., space-saving).

Melons require pollination for fruit set, higher yield, and to prevent misshapen fruit. Honey bees

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should be stocked in the melon field at one hive per acre for ideal yield. Melon plants produce both perfect and male flowers. There are more male flowers (pollen sources) than perfect flowers which will become melons. The latter will have a tiny melon behind the flower. Each pollen grain transferred to the stigma will become one seed. The more pollen, the more seeds; more seeds result in larger fruit size.

Good soil moisture is important both in early stages of growth and during pollination, when fruits are setting. Inadequate irrigation at these times will result in yield loss and reduce the number of marketable melons. Too much moisture later in melon development can cause splitting and rots, and it will also affect flavor.

Because many of the specialty melons belong to the same genus and species, they can readily interbreed. The resulting hybrids become plants whose fruit is very different in color, flavor, and texture from the parents, depending upon the divergence of the variants.

Melons generally mature 80 to 110 days after direct seeding; some Asian melons can mature in as few as 68 days. Sugar content is the principal measure of maturity. This is expressed as Brix content, or percent by weight of soluble solids (sugars) as gauged by the amount of light refracted through the plant liquid, indicated in degrees Brix ($^{\circ}\text{Bx}$). Farmers can test the Brix content of their crops in the field using a refractometer. Refractometers are sold in farm and garden supply stores and online.

The higher the Brix content, the sweeter the melon. For cantaloupes, 8°Bx is considered poor, 12 average, 14 good, and 16 excellent; for honeydew, 8, 10, 12, and 14, respectively. Brix content varies among melon varieties and is affected by growing conditions, soil condition, and maturity. Brix scores also can be used to make judgments on the health of the plant. Generally, the higher the $^{\circ}\text{Bx}$, the less likely the plant will be attacked by insects or disease. Plants with low $^{\circ}\text{Bx}$ are generally nutrient deficient and plagued with problems.

Plastic mulch can be used to conserve soil moisture and reduce weeds. Most commercially grown melons are produced with plastic mulch and drip irrigation. Different-color plastics offer different benefits, such as black mulch heating up the soil earlier, while blue mulch encourages vegetative growth. Blue-colored mulch has been found to be

more beneficial to melon crops than other colors (Gordon et al., 2008). Alternatively, deep mulching with wood chips, old hay, or fallen leaves can greatly reduce watering requirements in hot environments.

Because melons prefer a long, hot growing season, use plastic or biodegradable paper mulch and row covers in northern areas for earlier crops and better yields. Remove covers when plants have female flowers (tiny fruit at base of blossom). Paper mulch deteriorates too fast in the humid South to be very useful.



Melon field in full flower. Melons require adequate pollination to ensure good fruit set: one honeybee hive per acre is the suggested stocking rate. Photo: Dr. John Jifon, TAMU

Plastic mulch is also a good way to reduce weed populations in the field. In freshly transplanted rows, the melon plants should be inspected at timely intervals and any weeds found growing alongside the plants should be removed. Removal of weeds when small will prevent or reduce injury to the melon root system. Melons generally do not like to have their roots disturbed, so these early weedings are rather important.

Plastic mulch or not, the greatest weed threat to melons is nutsedge. Nutsedge pierces developing melons or even near-ripe melons. The resulting hole is an inlet for ants and other insects to the sweet innards of the melon. Grassy weeds in general are effective competitors with melon crops and should be controlled.

In some areas, producers use open-land furrow or sprinkler irrigation on melons. However, sprinkler systems spread fungal pathogens through rain-splash effects, and open-land furrow or flood irrigation is extremely wasteful of water resources. Thus, drip irrigation is preferred to better manage fungal pathogens.

Harvest and Ripeness

Some melon types, like honeydew, Canary, Spanish, and Crenshaw are non-slip types and thus

override by the time the stem can be tugged from the fruit. These must be cut from the vine.

Store ripe netted melons at near freezing; store other melons at 45 to 50°F (7 to 10°C) and 80% relative humidity for two to four weeks.

To determine ripeness, smell the melon; a more aromatic smell is a sign of ripeness and good taste. Some people “thump” melons with knuckles or an open hand and listen to the sound to determine ripeness: too high a timbre indicates that a melon is not ripe enough; too low a thump, overripe. A full, hollow sound should be just right. Feel the rind. Slight “give” is good; too hard or too soft melons should be avoided.

Marketing

Market Climate and Conditions

China dominates the global market for melons, with Turkey second; the United States posted fifth in overall melon production, but third in cantaloupes, in 2013. Due to climate conditions, most U.S. melon production is only possible from May through December; Latin American imports mostly fill the gap between January and April (Hoyle et al., 2014).

“Western” or “shipping” cantaloupes are commonly found on grocery shelves; they show netting on the rind and have orange flesh. They are routinely harvested when of uniform size but not fully mature (half-slip stage, when the stem partially pulls free) to account for shipping, storage, and shelf life. Small, local, direct market growers may find themselves at a severe disadvantage when attempting to compete with low-priced grocery

store melons. Fortunately, seed suppliers create an opportunity for smaller farmers by offering dozens of varieties of specialty melon seeds. These varieties are often popular with consumers for their vine-ripened sweetness.

High costs of production, increased competition from Central America, and quality-control problems have been significant factors in increased market pressures on U.S. growers. Additionally, extensive and continuing adverse climate conditions—droughts in Texas and California—have put pressure on commercial growers. For example, in Texas in recent years, total production has dropped from more than 11,000 acres in 2002 to less than 4,000 acres in 2012 (NASS, 2014). Parts of the American West, especially the southern portions, have been in drought for the last several years (as of this writing). In 2011, intense drought struck much of Texas and a large portion of the Southwest, bringing much of the region its worst drought since the Dust Bowl years of the 1930s; this was preceded by drought in California from 2008 to 2011. Since then, NOAA National Climatic Data Center indicates that in California, dryness levels have been rivaling historic droughts.

Direct Marketing

For the direct-market producer, shipping melons (*Cucumis melo L.*, Reticulatus Group) are probably not a good bet, as per-unit costs of production make them uncompetitive in price in small quantities. This condition, of course, is shared by producers of all stripe. It’s hard for a farmer with a few acres, for example, to compete in price with someone who grows produce by the mile.

To compensate for this, direct-market producers must rely on market strategy to increase competitiveness. Specialty melons offer an avenue to compete on the turf of large-scale melon producers. If you look in any major seed-supply catalogue, you will see an assortment of melons. Naturally, the major varieties are offered—and are perfectly suited for the hobbyist wishing to grow his or her own cantaloupes or honeydews to be plucked vine-ripe from the garden, at the epitome of taste, as opposed to shipped not fully ripe days or weeks beforehand. However, to be competitive in the market, growers should seek out niches to serve. Niche markets can be accessed through a variety of means, such as farmers markets, ethnic and conventional markets, roadside sales, and Community Supported Agriculture (CSA).

Nutritional Aspects of Melons

Their characteristic sweetness is both a plus and a minus for melons. One reason melons are popular is because they are flavorful and low in calories. Melons range from 40 to 80 calories per cup, depending on the melon type and its degree of ripeness. Riper melons contain more sugar. Overall, melons are low in saturated fat (only three of 60 total calories per 1-cup serving, or 177 grams, or 1% of daily value based on a 2,000 calorie diet) and low in sodium (28 milligrams or 1%), and very low in cholesterol (0 milligrams). They are a good source of dietary fiber (6%), niacin (6%), vitamin B6 (6%) and folate (9%), and a very good source of vitamin A (120%), vitamin C (108%), and potassium (14%). The drawback is that the majority of calories from the fruit are from sugars (13.9 grams) (USDA-ARS, 2014). Another negative of the high sugar content for growers is that vertebrate pests also favor the sweet-tasting fruit. Melons also contain an array of antioxidant phytochemicals such as coumarins, saponins, tannins, and beneficial alkaloids (Muller et al., 2013).

Farmers markets have been steadily gaining in popularity. The USDA Agricultural Marketing Service reports that there was a 3.6% rise in the number of farmers markets from 2012 to 2014. This number is expected to continue to rise as more people start to value the benefits of local food. Farmers markets allow producers to meet with local people and build relationships with their consumers, an option not afforded in other venues.

Ethnic groceries help both recent immigrants and farmers. Many immigrants find themselves separated from the foods of their homelands. This demand becomes an opportunity for local farmers to market the vegetables, fruits, and herbs that are adaptable to their region to newcomers. It may be difficult for a local producer to sell produce directly to the people who would most benefit from it; thus a middleman of the same culture becomes prudent. Ethnic grocery stores then become an outlet for farmers to reach audiences they didn't have access to before. It can be particularly advantageous for farmers to time their harvests for a specific event of their target audience.

Some conventional grocery stores will purchase produce directly from producers. This gives the farmer a dedicated buyer for his or her crop and allows the store to brand itself as supportive of the local food movement. This option tends to be less attractive to farmers, as the other options usually are more profitable and less troublesome with regard to the amount of paperwork required of the farmer.

Roadside sales are another direct-marketing strategy for producers. Farmers markets tend to have an array of many types of vendors, whereas roadside stands are a stand-alone operation. These tend to attract fewer customers, with the customers spaced over a longer period of time. These stands tend to be seasonal in nature, according to the harvest. Many factors play a part in the success of roadside stands. For example, a farm stand between Hempstead and Brenham, Texas, in the spring when the bluebonnets are flowering would have many customers who were interested in stopping on that stretch of road anyway. Differentiate that from travelers heading from Houston to Galveston, Texas, who have NO intention of stopping for any reason.

Other marketing options are available to specialty melon growers. CSAs are still developing and evolving. The original concept was for the subscriber to pay at the beginning of the sea-

son for a share of the produce a particular farm produced throughout that season. This model is adapting due to market forces and competition. Nevertheless, it is still an option for producers to supply their customers with high-quality produce. Home-delivery services have also arisen in the past few years as a viable outlet for producers to sell their products.

Types of Specialty Melons

Common melon varieties include cantaloupe, Casaba, Crenshaw, Galia, Hami, Honeydew, Juan Canary, Orange-flesh honeydew, Sharlyn, and Santa Claus Melon. Additionally, Asian Melons are increasingly popular. These are small, oblong, moderately sweet melons with crunchy white flesh, commonly found in Korea and other Asian countries.

For the market gardener or small producer, it might be more profitable to focus on less abundant melon varieties. For example, Asian melons are only now capturing a foothold in the U.S. market. These Asian melons, such as the Sun Jewel melons finding popularity among gardeners and specialty crop growers, are not as sweet as melons commonly found on grocer's shelves. Oblong fruits measuring 7 inches by 3½ inches, they are bright lemon-yellow in color. The flavor is sweet and the pale flesh is firm, even crisp or crunchy. Their bright appearance can surprise some shoppers, who have mistaken them for squash!

Similarly, the Canary melon (often called a Juan Canary melon, *Jaune des Canaries*, and *Amarillo* melon marketed in Asia, e.g., Japan, South Korea) offers an inviting alternative to cantaloupes. An oval-shaped, bright yellow, non-netted Casaba type variety, the Canary melon has a relatively firm flesh, like a pear, and tangy flavor with pale coloration. It has a long shelf life; hence, it's often called a winter melon (not to be mistaken for the winter melon/wax gourd *Benincasa hispida*) because it matures in late summer. Along the lines of bright-yellow exterior, the Lilly melon offers a sweeter taste (up to 17% Brix content) and spicy flavor. A hybrid Crenshaw melon, it has creamy aromatic flesh the color of cantaloupe. Oblong, averaging six to eight pounds, it has a shorter growing period (75 to 85 days) than most Crenshaws.

Growers may also want to consider these melon varieties:

- Santa Claus – Also known as Christmas melon or *piel de sapo*, this is a type of

Schoon's Hardshell Melons

According to tradition, Lambert Schoon came across a farmer with melons that he couldn't sell, so Schoon took them. He came up with the idea that if he crossbred his melons with the unsaleable one he might have a better melon. Eventually, Schoon perfected his melons in a unique way. When the melons were ready for picking, he would stop on his way home from the fields at the houses of all his family and friends, dropping off about five melons in baskets they all kept by their back doors. He told them "Eat a melon. If it's not great throw it away—if it's good, just save the seeds for me." Everyone complied, and at the end of the season they each had about two or three pounds of seeds saved for him in salt bags. After perfecting his melon over time, he began to sell the melons, and they became known for many miles. After Lambert Schoon retired from farming, a national seed company began using his name to sell the famous "Schoon Hardshell Melon" seeds across the country. These seeds were thought to be lost in 1997, but now Baker Creek has them available. (Contact information appears in the Further Resources section.)

muskmelon with a long shelf life, popular in winter (hence, its name) when shipped from Latin America. It has mottled bright green and yellow skin like a watermelon, but its flesh is like a honeydew. The fruit can grow to a foot in length and weigh as much as 10 pounds.

- Lambkin, or Early Piel de Sapo – Another very sweet, unusual melon is this Spanish melon that grows small, 3-pound fruits with a green-spotted rind like a watermelon and white flesh. It also is an early maturing melon.
- Casaba – Named for its origin in Kasaba, Turkey, and imported to the United States in the late 19th century, this melon has a thick ridged, golden-yellow skin with green traces and creamy vanilla-orange flesh. Harvest when the blossom end softens, rind is slightly golden, and the vine slips.
- Crenshaw – This is a large, oval-shaped melon with a yellow-green ridged skin and bright orange flesh. Harvest when the blossom end softens.
- Emerald Jewel, Emerald Pearl, Tokyo King – These are melons from Japan. They are small, three to four pounds with a netted brown or green rind. Emerald Jewel and Tokyo King have bright white flesh and are very sweet and juicy; Emerald Pearl has green, crisp flesh.
- Galia – This hybrid developed in Israel resembles a cantaloupe on the outside and

honeydew on the inside with netted rind and light green flesh. It is often labeled as Mediterranean, Passport, Israeli, or Middle Eastern melon. It is very sweet, with 18°Bx possible, though it is usually picked and shipped at 11°Bx.

- Hami – A type of sweet, juicy muskmelon originating from the Xinjiang region of Northwest China, this melon has white flesh tinged with pink. Its yellow rind can be slightly netted, and it is oblong in shape and pointed at the blossom end.
- Orange-Flesh Honeydew – This melon is like a cantaloupe with the size and shape of honeydew.
- Sharlyn – This melon is oblong, with a greenish-orange rind. It is very thin-skinned, with white flesh tasting between honeydew and cantaloupe. These melons have a short shelf life.

Growers also have the option of several non-*Cucumis melo* specialty melons:

- *Benincasa hispida* – Known as winter melons, these usually are found in East Asian cuisines. The fruit is also called wax gourd because as it matures it sheds its trichomes and develops a thick, waxy cuticle. The melons are used fresh, juiced, or in prepared meals. Culture is the same as for watermelon.



Wintermelons start out hirsute, or fuzzy, such as the one pictured here. As they mature, they lose their fuzz and develop a thick cuticle of waxy coating. This cuticle is a natural barrier against pests, diseases, and moisture loss, which makes this an ideal melon for storage purposes. Photo: Art Whistler, copyright 2011, used with permission

- *Cucumis metulifera* – This African melon is also called kiwano, horned melon, or melano. Its fruit is armored with horns and quite decorative. The peels are rich in vitamin C and dietary fiber but not flavored compatibly to the western palate.



Cucumis metulifera. A spined, jelly-filled melon. Kiwanos are more of an ornamental oddity than vegetable crop at this point. Photo: Hobby Kafe

- *Momordica charantia* – Called bitter melon or Bitter gourd, these are, in fact, very bitter. Jamaicans call them “cerasee” and use the leaves as a cleansing bitter tonic. Filipinos call the melons “ampalaya” and use salt to draw out the bitterness before cooking.
- Egusi – These melons are grown for seed production rather than the meat. The egusi melons I have encountered actually had very bitter flesh, possibly poisonous. Several different species of melon can be used for egusi, although the most common is closely related to watermelons.



This particular egusi melon resembles a small watermelon. These melons are beaten or cut into halves, then piled up, covered in the field, and left to deteriorate for a few days to aid in extracting the edible seeds. These seeds are then washed, dried, and later peeled, thus readying them for cooking. Photo: A. Davis, USDA-ARS

Current Research

As specialty melons become more popular, university scientists and producers have been conducting research on the best methods to produce them successfully. Selected research results are summarized below:

- Salandanan (2009) and colleagues found in Colorado that organic melons produced more ascorbic acid, but that total phenolics were environmentally dependent.
- Galia melons in Missouri were found to be very well suited to high-tunnel production and out-performed the nearest competitor by six pounds per plant (Jett, 2005).
- University of Kentucky has been trialing specialty melons for a number of years through its Center for Crop Diversification. Successful trials showed that specialty melons are a viable option for the Midwest (Strang et al., 2004, 2005, 2007, and Strang, 2012).
- Research in Florida showed differences in diseases that afflicted melons by cultivation method. Melons grown using synthetic chemicals were widely affected by powdery and downy mildews, while some organic melons showed signs of gummy stem blight (Guan et al., 2012).
- Other Florida research showed some success in reducing root knot nematode (*Meloidogyne spp.*) by grafting specialty and other melons onto *Cucumis metulifer* (horned melon, a close relative) rootstocks (Guan et al., 2014).
- Researchers in Georgia found that in their location some specialty melons did not have good disease resistance using organic methods (Boyhan et al., 2013).
- A Sustainable Agriculture Research and Education (SARE) grant recipient found that open-pollinated varieties perform much better than hybrid varieties in Maine (Percy, 2012).
- In a Cornell study, specialty melons were found to be more susceptible than conventional muskmelon varieties to powdery mildew (McGrath et al., 2007).

- A trial conducted at the University of Arizona found that grafting organic melons increased yield but also increased the break-even costs and the relative production cost dramatically (Tronstad et al., 2008).
- Galia melons performed equally as good if not better than conventional muskmelon varieties in Iowa (Lawson, 2009).
- Research in South Texas showed that the irrigation requirement is variety-dependent in specialty melons. Some need less irrigation water and will still attain good yields (Sharma et al., 2012).
- Some specialty melons have improved disease resistance and higher antioxidant levels. These include new melon cultivars “Pacal” orange casaba and “Chujuc” cantaloupe, both with high levels of beta-carotene and sugars, along with excellent flavor (Crosby, 2008).

Major Insect Pests

There are no insect-proof melon varieties. Early planting helps reduce some losses caused by late-season insects. Cucumber beetles (order Coleoptera, family Chrysomelidae) and melon aphids (*Aphis gossypii* Glover, order Homoptera, family Aphididae) are major insect pests for melons. The pest responsible for most melon losses, up to 75% in uncontrolled infestation (Matocha et al., 2009), is the sweet potato whitefly: *Bemisia tabaci* (Order Homoptera, family Aleyrodidae). Control options for some of the major insect pests of melons are discussed below.

Aphids

Aphids (*Aphis gossypii* Glover) are the most troublesome on young plants. Older plants are more tolerant of aphid feeding. Using protective floating row covers can reduce losses and also help prevent viruses transmitted by aphids. Covers can be applied in the field after transplanting.

Aphid remedies for small growers include using a hose to flush aphids from leaves and stems, including undersides. Heavy rains can also deter aphid spread, but high humidity can cause fungal problems.

Beneficial insects can be used to counter even heavy infestations, but they are more effective

when released before pests reach economic thresholds. Common insects for aphid control include various species of lady bird beetles or “lady beetles” (*Hippodamia spp.* and others). A single adult lady beetle can consume hundreds of aphids per day. Garden supply houses sell lady bird beetles in bulk. One species often sold is *Hippodamia convergens* or the convergent Lady Beetle. According to ATTRA’s *IPM Field Guide*, the problem with this species is that they have a tendency to flee the site.

To retain active lady beetles, the ATTRA publication *Farmscaping to Enhance Biological Control* suggests maintaining cover crops or other hosts of aphids or alternate prey in strips or nearby plots. Some examples include plants of the carrot family [fennel, angelica, dill, tansy, bishop’s weed (*Ammi*), Queen Anne’s lace] or sunflower family (goldenrod, coreopsis, cosmos, golden marguerite (*Anthemis*), dandelion, sunflower, yarrow], as well as crimson clover, hairy vetch, grains and native grasses, butterfly weed (*Asclepias*), buckwheat, euonymus, rye, hemp sesbania (*Sesbania exaltata*), soapbark tree, buckthorn (*Rhamnus*), saltbush (*Atriplex spp.*), and black locust (*Robinia pseudoacacia*).

Other natural remedies include horticultural oils, insecticidal soaps, *Beauveria bassiana*, and Neem. Using a pesticide should be a remedy of last resort. Practicing Integrated Pest Management (IPM) helps forestall extreme remedies. IPM measures include choosing plant varieties that are resistant to pests in your region, adequately preparing the soil before planting (including natural fertilizers, compost, and proper soil composition), and ensuring adequate irrigation. Other, more aggressive, IPM steps (often called bio-intensive IPM) include planting adjacent crops that invite beneficial insects or using “trap crops” that lure pests away, as well as purchasing beneficial insects to introduce to the crop. Monocultures are particularly susceptible to insect infestations, so designing plantings for diversity is a positive IPM technique. Remember that insecticide sprays (even those approved by the Organic Materials Review Institute, or OMRI) are generally broad-based and can be dangerous to beneficial insects such as honeybees and other pollinators, as well as pests.

Mammals, birds, bats, insects, fungi, bacteria, and viruses all have a role to play as predators and parasites in an agricultural system. Pesticides decrease the biodiversity of a system, creating the

potential for future problems. When supplemental controls must be used, biorational pesticides should be considered. These are generally derived from naturally occurring compounds or are formulations of microorganisms. Organic Insecticides that can be used to help control aphid infestations include pyrethrins. For more information, consult ATTRA's *Biorationals: Ecological Pest Management Database*.

Cucumber Beetles

Cucumber beetle is a common name given to members of two genera of beetles, *Diabrotica* (spotted) and *Acalymma* (striped), both in the family Chrysomelidae. Cucumber beetles are present throughout the United States and cause serious damage to cucurbit crops. Overwintering adult insects feed on young plants, larvae in the soil feed on plant roots, and second-generation adults feed on plant leaves, blossoms, and fruits. Furthermore, adult cucumber beetles serve as vectors of bacterial wilt and squash mosaic virus.

Although cucumber beetles prefer flowers and leaves, they can also cause cosmetic damage to the surface of the melon that reduces the value of the crop. They are difficult to control through IPM strategies. They do have natural enemies, but introducing these is usually not enough to protect marketable yields of fruit; nor are insecticides particularly effective, as the two major beetle varieties either develop outside of the fields being treated or lay their eggs at the roots, where larvae are difficult to control.

Organic and biointensive IPM measures include delaying planting until beetles have already laid their first generation of eggs and using trap crops, floating row covers, parasitic organisms (such as the Tachinid fly *Celatoria*), and botanical pesticides. Field scouting or yellow sticky traps can help growers monitor insect populations. Trap crops provide attractive scents and colors for the beetles. These may include zucchini, squash, and pumpkins. Sow 5% or more of the land in strips alongside the crop or in adjacent plots with trap crops; these plants produce cucurbitacin, a feeding stimulant to cucumber beetles. The traps can either be destroyed or sprayed with a highly concentrated (30ml per gallon of water) citrus oil solution to destroy the adult cucumber beetle population.

The ATTRA publication *Cucumber Beetles: Organic and Biorational Integrated Pest Management* reports

that some squash varieties have greater amounts of the cucumber beetle attractant cucurbitacin:

- Black Jack zucchini
- Big Max pumpkin
- Cocozelle summer squash
- Green Eclipse zucchini
- Seneca zucchini
- Senator zucchini
- Baby Boo pumpkin
- Super Select zucchini
- Ambercup buttercup squash
- Dark Green zucchini
- Embassy Dark Green zucchini
- Caserta summer squash
- Classic melon

Large-scale pest vacuums have also proven effective in removing beetles. Insecticides such as pyrethrums, which are derived from the extract of chrysanthemum flowers, can be used to help control beetle infestations. However, it should be noted that these generally not only have long residual activity but also are highly toxic to some beneficial insects. Moreover, their use may destabilize insect populations and result in outbreaks of secondary pests like aphids. Note that while pyrethrums are natural (though potent) insecticides that are generally approved for certified organic crops, pyrethroids are synthetic versions that are not approved for certified organic crops.

According to the Alabama Cooperative Extension Service, Adios (a Sevin bait) has proved moderately successful in controlling cucumber beetles. Although used as a foliar spray, Adios acts as a bait because it contains a cucumber beetle-feeding stimulant along with 13% carbaryl insecticide. When Adios is sprayed on foliage, beetles are stimulated to feed on the compound and are killed by the carbaryl. In field tests, Adios has provided cucumber beetle control ranging from less than to equal to foliar insecticides. It has no harmful effect on beneficial insects, including pollinators, because insects other than cucumber beetles are not stimulated to feed on the compound (Zehnder, 1997).

For this reason, Adios is approved for organic application by OMRI:

May be used as a pest lure, repellent, or as part of a trap, or as a disease control. May be used for other pesticidal purposes if the requirements of 205.206(e) are met, which requires the use of preventative, mechanical,

physical, and other pest, weed, and disease management practices. (OMRI, 2015)

Note that although Adios is a formulation of Sevin, Sevin itself should be avoided because it is toxic to earthworms, pollinators, and wasps (several of which are beneficial insects) and its use can lead to secondary insect pest infestations.

Neem has been found to have little effect on beetle survival or mortality, but its anti-feedant trait significantly reduced plant damage caused by beetles. Rotenone and cryolite were both moderately effective. Entomophagous nematodes can control the larval stage in the soil (Toepfer et al., 2005). More information is available in the ATTRA publications *Cucumber Beetles: Organic and Biorational Integrated Pest Management* and *Farmscaping to Enhance Biological Control*.

Squash Bug

The squash bug, *Anasa tristis* (DeGeer), attacks cucurbits throughout the United States, Central America, and southern Canada. Generally, squash bugs can be deterred through proper field sanitation, including destroying old plants so bugs don't overwinter and utilizing bio-intensive IPM methods, such as using vacuums or hand-picking egg masses. For information specific to squash bugs, see the ATTRA publication *Squash Bug and Squash Vine Borer: Organic Controls*.

Thrips

Thrips, members of the order Thysanoptera, which contains a number of genera and species, can attack melons. Thrips feed by rasping the leaves and other tissues of plants to release the sap, which they then consume. This feeding reduces the plant's ability to produce food as it causes silvery patches to appear on the leaves. Certain field conditions exacerbate thrips, including drought. Plant sunflowers in strips or in multi-crop with melons to encourage beneficial insects that attack thrips or use plastic mulch to kill pupating thrips that fall to the ground. More information specific to thrips is available in the ATTRA publication *Thrips Management Alternatives in the Field*.

Other Insect Pests

Other insect pests, including armyworm, melon worm, spider mites, broad mites, sweet potato white flies, and melon fruit flies, may also damage melons. There are several strategies that can help control these (USAID, 2013):

- Use *Bacillus thuringiensis* (Bt) insecticides to kill army worms and melon or pickle worms
- Install live barriers and plant away from dusty roads to deter spider and broad mites
- Maintain crop surroundings free of broad-leaf weeds to deter white flies
- Use sex pheromones to prevent mating and reproduction of melon fruit flies

In addition to proactive IPM, several biorational insecticides can be used effectively to reduce infestations of leafminers, flea beetles, cabbage loopers, and cutworms. These biorational options include Bt insecticides, Neem, diatomaceous earth, and spinosad. To find more information on these and other biorational insecticides, consult ATTRA's *Biorationals: Ecological Pest Management Database* at <https://attra.ncat.org/attra-pub/biorationals/>.

Vertebrate Pests of Melons

Raccoons, deer, opossums, birds, and other creatures are attracted to melon plants and fruit. For ideas on how to control damage from these pests, consult the ATTRA publications *Deer Control Options* and *Organic IPM Field Guide*.

Major Diseases

Some diseases that afflict melons can be prevented or controlled through appropriate IPM techniques and by using good agricultural practices. These may include rotating crops, composting or otherwise disposing of diseased plant residue, and encouraging mycorrhizae.

Fusarium wilt, downy mildew, powdery mildew, Alternaria, and gummy stem blight are serious diseases of melons. They usually attack the plants at fruit-sizing time. Root-knot nematodes can also be a problem, as well as anthracnose, virus complex, vine decline, and fruit rot. Some melon varieties resist several pathogens, such as Fusarium wilt and powdery mildew. Some varieties tolerate sulfur, which can be used to control powdery mildew (Lineberger et al., 2009). Specific information on managing each of these diseases is provided below.

Fusarium wilt (*Fusarium oxysporum* f. sp. *Melonis*) is a serious soil-borne disease of muskmelons. It is a fungal disease often encountered as a rapid wilting and vine decline of mature plants or

sudden damping off of seedlings. Initially, leaves of infected plants wilt during hotter times of the day when stressed, but eventually, the wilt becomes permanent. It may affect a few plants at first, then spread. A yellow or brown discoloration may be noticed when the stem is cut in cross section. Texas A&M AgriLife Extension recommends using melon seed varieties that are resistant, as the fungus may survive in infected fields for many years and may be spread from field to field by farm equipment.

Downy mildew (*Pseudoperonospora cubensis*) is a fungal disease that usually is encountered during rain and periods of high humidity and cool temperatures. Symptoms first appear as pale green areas on the upper leaf surfaces. These change to yellow angular spots. A fine white-to-grayish downy growth soon appears on the lower leaf surface. The entire plant may eventually be killed. Downy mildew does not overwinter beyond Mexico and the southernmost tier of U.S. states. As a result, the disease is most common on late-summer plantings and is infrequently seen on spring cucurbits. The fungus can be managed by using disease-resistant seeds. Good IPM measures can reduce the incidence. These include good soil fertility management backed up with foliar fertilization for healthy plants, as well as selecting growing sites with good air drainage, full sunlight, and low humidity. Using drip irrigation or scheduling overhead irrigation to avoid excessive leaf wetness will also reduce disease incidence. When detected early, disease spread might be slowed somewhat by removing and destroying infected plants, and by taking care not to transport the disease by hand or on infected tools and equipment. For more details, consult the ATTRA publication *Downy Mildew Control in Cucurbits*.

Powdery mildew (*Sphaerotheca fuliginea*, *Erysiphe cichoracearum*) is a fungal disease that usually appears first as spots on leaves, then as a white powdery “dust” that covers the leaves until they turn brown and papery. Powdery mildew usually occurs during cool, dry weather. The fungus can be managed by using disease-resistant seeds and fungicides when the spots first appear. Several studies have shown that a solution of cow’s milk and water is effective in controlling powdery mildew when it is applied in bright sunlight (Bettiol, 1999).

Alternaria leafspot or blight of cucurbits (*Alternaria cucumerina*) is a fungal disease that usually

appears after warm, wet weather. It is characterized by round spots or lesions on the crown leaves of the plant that spread to the other leaves and eventually defoliate the vines. Spores overwinter in diseased plant remains and decayed crop residue. *Alternaria* is usually only vigorous on weakened and stressed plants. The fungus can be managed by active IPM preventative measures, such as proper soil preparation, crop rotation, and using disease-resistant seeds.

Gummy stem blight [*Mycosphaerella melonis* (*Didymella bryoniae*)] is a fungal disease that usually develops from contaminated seed and can be visible on transplants. It is characterized by round, black, wrinkled spots on young leaves and dark sunken areas on stems. The stems usually split, and a light brown gum oozes from them. Leaf spots usually increase in size and kill the leaves. Fruit develop wet lesions that eventually turn brown and ooze a sticky sap. The fungus can be managed by using disease-resistant seeds; the fungus survives on crop residue, so proactive IPM can help prevent recurrence.

Root-knot nematodes (*Meloidogyne* species) are a type of nematode (tiny, eel-like roundworms) that causes galls or swellings on plant roots. These hamper nutrient uptake by the root system, resulting in yellowed leaves and a stunted plant. Nematode feeding also creates open wounds that provide entry to a wide variety of plant-pathogenic fungi and bacteria. These microbial infections are often more economically damaging than the direct effects of nematode feeding. Infestation is often from infected transplants. Light, sandy soils generally harbor larger populations of plant-parasitic nematodes than clay soils.

For control, the ATTRA publication *Nematodes: Alternative Controls* suggests the following:

- Use certified planting material
- Use soilless growing media in greenhouses
- Clean soil from equipment before moving between fields (washing equipment—including tires—with water is most effective)
- Keep excess irrigation water in a holding pond so that any nematodes present can settle out; pump water from near the surface of the pond; plan irrigation to minimize excess water

- Prevent or reduce animal movement from infested to uninfested fields
- Compost manure to kill any nematodes that might be present, before applying it to fields
- Eliminate important weed hosts such as crabgrass, ragweed, and cocklebur

Others have had success either using crab shell meal or a crab shell-derived product, Clandosan, to control nematodes. These products increase the number of chitin-feeding organisms in the soil; these organisms then feed upon the nematodes.

Several species of soil-borne fungi, such as *Verticillium chlamydosporium*, also feed on pest nematodes, which is why it's so important to maintain proper soil microbiology.

Anthracnose (*Colletotrichum orbiculare*) is a fungal disease that usually develops with warm, wet weather because the spores depend on water for spread and infection. Anthracnose is usually first detected as sunken spots on the rinds of fruit; lesions can girdle the stem and cause vines to wilt. Proactive IPM, including crop rotation and buying disease-resistant cultivars, is the best method for management. Be aware that wash water on harvested fruit may spread the disease, and spores may be present on workers' clothing or on wet farm equipment. Cucumber beetles can also spread the disease to other plants and fields. Using fungicides to control anthracnose is not considered profitable.

Vine decline is caused by a fungus (*Monosporascus cannonballus*) often found in silt or clay soils that causes plants to wilt and die. Plants usually do not develop symptoms until near harvest time. Because fungi populations build through continued cucurbit monoculture, the remedy is to rotate crops or not plant cucurbits in the affected area.

Virus complex includes a number of mosaic viruses, so-called because leaves of infected plants have a mottled pattern of light and dark coloration.

This pattern can cause raised areas on the leaves or distort the shape of the leaves. When plants are infected, young fruit may be aborted and the fruits that survive may be malformed. Texas AgriLife Extension Service offers advice for dealing with the different mosaic viruses, as described below (Lineberger et al., 2009).

Cucumber mosaic virus (CMV) is a frequent problem for melons, attacking melons early on; infected plants are stunted, often with poorly expanded leaves. Plants are bushy in appearance. Leaves may be mottled and often have a "shoe-string" appearance. Fruit are small and misshapen. The virus is usually spread by aphids (sometimes seed-borne), so control the aphids and eliminate weeds and diseased plants to control CMV.

Watermelon mosaic virus 2 (WMV-2) can infect and produce symptoms on all commercially grown cucurbits. Infected plants show a characteristic green/yellow mosaic pattern. Leaves become stunted and misshapen. Fruit is bumpy and distorted and may also fail to develop normal coloration. This disease is also spread by aphids, so control the aphids and practice aggressive IPM methods, such as plowing residues from previous crops, rotating fields, and other good sanitation practices.

Zucchini yellow mosaic virus (ZYMV) has characteristics very similar to WMV-2 and is also transmitted by aphids. Fruits may be stunted or malformed. For control, use aggressive IPM.

Squash mosaic virus (SqMV) can cause distorted leaves and stunt fruit; older plants may appear normal but stems may not fully branch out and may produce mottled, distorted fruit. The virus is seed-borne in muskmelon and is mainly spread by cucumber beetles. For control, use aggressive IPM.

Melons also may be attacked by Tobacco ringspot virus, which is mainly transmitted by nematodes but may also be seed-borne. It is characterized by leaves displaying a bright mosaic and by plant stunting.

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Further Resources

ATTRA Resources

These databases and publications are available at the website www.attra.ncat.org.

Biointensive Integrated Pest Management: Fundamentals of Sustainable Agriculture

Biorationals Ecological Pest Management Database
Cucumber Beetles: Organic and Biorational Integrated Pest Management
Directory of Organic Seed Suppliers
Downy Mildew Control in Cucurbits
Farmscaping to Enhance Biological Control
Nematodes: Alternative Controls
Squash Bug and Squash Vine Borer: Organic Controls
Thrips Management Alternatives in the Field

Web Resources

Biology and Management of Aphids in Organic Cucurbit Production Systems by Dr. Mary E. Barbercheck, Penn State University Extension. www.extension.org/pages/60000/biology-and-management-of-aphids-in-organic-cucurbit-production-systems

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Melons. Agricultural Marketing Resource Center. www.agmrc.org/commodities__products/vegetables/melons/

Seed Sources

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Grafting clips.com
www.graftingclips.com/products/clips-for-watermelon
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