Pests and Disease Management

The purpose of the following material is not simply to provide strategies for increasing production. The real objective is to assist producers in achieving more cost-effective production, thereby improving the profitability of their avocado operations.

Arthropod Management in Avocados

Arthropod management in avocados is a strategy which encourages the reduction of pesticide use by using a variety of controls in combination to contain or manage pests. It is based on proper identification of the pest, monitoring, action levels and appropriate action. Avocado growers should have a good training and understanding of pest management techniques. Monitoring pests and their natural enemies is a vital component of pest management. Monitoring can be carried out by a commercial pest scout or by the grove manager. In either case, it must be done in a systematic manner. Action must be taken to control pests before the point at which they cause economic loss. Action levels are usually based on research and experience. When action levels of a pest are reached, the most appropriate control strategy must be selected, e.g., release of parasites, use of a selective pesticide. If a pesticide is to be used, its effect on natural enemies must be considered first.

Suggested Control Program

Because of variations in the development of harmful insect infestations, it is necessary to determine if and when pesticidal treatments ar needed. It is not only unnecessary, but wasteful or even harmful, on occasions, to apply insecticides unless they are needed.

- December, January, February:
  - Control avocado red mites, if needed.
- January, February, March:
  - Control bloom-infesting insects—mirids, thrips, caterpillars—if needed.
- May, June, July:
  - Look for infestations of avocado loopers.
  - Control scale insects, mealybugs or insect infestation on fruit, if needed.
- August, September, October:
  - Control greenhouse thrips, if needed.
  - Control fruit-scarring caterpillars, if needed.
List of Insecticides Registered for Use on Avocado

NOTE: The following insecticides are listed by the EPA as being cleared for use on avocados (see Table below for details on use):

- Bacillus thuringiensis (Biobit, Cutlass, Dipel, Javelin, Vault, XenTari)
- carbaryl (Sevin); malathion (Cythion)
- metaldehyde (slugs and snails); methomyl (Lannate)
- permethrin (Ambush, Pounce); pyrethrins + rotenone (Pyrellin)
- oils (Sun Spray, Volck oil); rotenone (Rotacide)
- soap, insecticidal (M-Pede); sulfur (Thiolux, SuperSul)
- diatomaceous earth + pyrethrin + pbo (Diatect Organic Plus)

Pesticides registered for avocado in Florida

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Brand Name</th>
<th>Pests Controlled</th>
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<tbody>
<tr>
<td>azadirachtin</td>
<td>Align, Azatin</td>
<td>General insecticide</td>
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<tr>
<td>spinosad</td>
<td>Spint Tor 2 SC</td>
<td>Lepidoptera</td>
</tr>
<tr>
<td>abamectin</td>
<td>Agri-mek</td>
<td>Thrips, mites</td>
</tr>
<tr>
<td>Pyrethrin + rotenone</td>
<td>Pyrellin</td>
<td>Aphids, lepidoptera, thrips</td>
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<tr>
<td>sulfur</td>
<td>Sulfur 6L, Sulfur</td>
<td>Mites</td>
</tr>
<tr>
<td>malathion</td>
<td>Malathion</td>
<td>Thrips, scales, lepidoptera</td>
</tr>
<tr>
<td>permethrin</td>
<td>Pounce, Ambush</td>
<td>Thrips, lepidoptera, lacebug, mirids, soft scales</td>
</tr>
<tr>
<td>Various refined horticultural oils</td>
<td>Sunspray, citrus spray oil, crop oil, FC435-66,FC 455-88, others</td>
<td>Aphids, mites, scales, mealybugs</td>
</tr>
<tr>
<td>Potassium salts of fatty acids</td>
<td>Safer Soap</td>
<td>Aphids, lacebug, mites, thrips, scales, mealybugs</td>
</tr>
<tr>
<td>methomyl</td>
<td>Lannate</td>
<td>Lepidoptera</td>
</tr>
<tr>
<td>Bacillus thuringiensis</td>
<td>Dipel, others</td>
<td>Lepidoptera</td>
</tr>
<tr>
<td>Beauveria bassiana</td>
<td>Mycotrol</td>
<td>Lacebug</td>
</tr>
<tr>
<td>pymetrozine</td>
<td>Endeavor</td>
<td>Aphids, whiteflies</td>
</tr>
<tr>
<td>kaolin</td>
<td>Surround</td>
<td>Barrier and irritant to various insects</td>
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<tr>
<td>pyriproxyfen</td>
<td>Knack</td>
<td>Scales, thrips, ants</td>
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<tr>
<td>S-methoprene</td>
<td>Extinguish</td>
<td>Ants</td>
</tr>
<tr>
<td>hydramethyphon</td>
<td>Amdro</td>
<td>Ants</td>
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<tr>
<td>bifentrazate</td>
<td>Floramite</td>
<td>Mites</td>
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<tr>
<td>fenpropathrin</td>
<td>Tame</td>
<td>Various insects, mites</td>
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<tr>
<td>hexythiazox</td>
<td>Savey</td>
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</tr>
<tr>
<td>bifenthrin</td>
<td>Talstar</td>
<td>Various insects, mites</td>
</tr>
</tbody>
</table>

These materials are sold under various trade names. The individual labels often differ from each other. Labels for some of these pesticides were not available at the time of printing. In order to find the individual label that has specific directions for your use, contact the local County Agricultural Extension office or agricultural supply dealer. Under the FIFRA amendment of 1978, the grower may use a material (insecticide) that is legal and EPA-approved for a pest on a crop for other non-listed pests as long as the user follows the label directions and rates for the approved pest.

Precautions and Restrictions

Lannate is especially toxic and is not recommended for dooryard avocado trees. **Lannate should also be handled with great caution.** They should be used only by trained and properly equipped operators. Oil emulsion sprays may injure trees if applied during a very cold, dry period or a hot (90°F) period. Do not mix sulfur with oil emulsion, or apply either material within 3 weeks of the other. Do not apply malathion within 7 days of harvest. Do not apply Lannate within 7 days of harvest. There is no required waiting period for oil emulsion or sulfur.

General Information on Pests

Avocado Tree Girdlers

The adult is a snout beetle. Small trees up to 6 inches in diameter at the ground level are most susceptible. Reddish-colored frass is extruded by the larvae from the feeding burrows and is observed near the ground level.

Avocado trunks damaged by tree girdler larvae

Control
Two or more annual examinations of the tree bases for frass is recommended. Remove the larvae and paint the wounds with good tree wound paint.
Caterpillars

Several kinds of caterpillars may infest avocado bloom, clusters and leaves. One is a web-spinning caterpillar that feeds on buds, blooms and leaves. An outstanding characteristic of infestation is masses of bloom webbed together. Secondly, there are several loopers that feed on avocado leaves in Florida. The most common of these is *Epimeces detexta*. This looper is the larva of a medium-sized grey or greyish-white moth. Young larvae are 1/4 inch or less in size and usually grey or greyish black; they grow rapidly to 1 1/2 inches or more in length. Older larvae are generally tan or greenish-yellow in color. Larvae feed also on flower panicles and even fruit, but prefer the tender growth in the upper part of the tree. Looper infestations appear to be somewhat seasonal and are more severe in spring and summer, generally becoming less of a problem in fall and winter.

Life Cycle

The adult moth is short-lived and mates and oviposits soon after emergence from pupa. Eggs are laid in narrow, elongated masses, preferentially on needles of Australian pine (*Casuarina* sp.) They hatch in about 5 days. The larvae grow rapidly and pupate 17-22 days after egg hatch. The pupal stage can last 10 days. Thus, a full generation is expected to last between 34-37 days. Pupae drop to the ground and the adult emerges in 12 days to start the cycle over. Some avocados are culled because of damage from feeding on the fruit by two or three kinds of small caterpillars.

Larvae of Avocado looper
Foliage damage from avocado loopers

Damage to fruit caused by avocado loopers

Action Levels
Young trees are more affected than mature trees. If 20 larvae or more are observed feeding on trees, and trees are severely defoliated, there is need for control. For older trees, if there are small fruits in the grove and more than 30 larvae are collected during a 30-minute inspection of foliage, there is need for control. If there are no fruits, the tree can stand defoliation of at least 40% of the tree canopy.

Control
Apply malathion. Lannate 90 WP, Lannate 1.8 L liquid have been cleared for Avocado Leafroller, Avocado Looper, and omnivorous leafroller. Pyrelin (pyrethrins + rotenone) is legal for use against caterpillars. The WP is applied at 1/2 - 1 lb 90% powder/acre. The liquid 1.8 is applied at 2-4 pints per acre. Bacillus thuringiensis (B.t.s) is sold under several trade names and has affect on certain types of caterpillars. The grower should discuss labels and specific recommendations with the local pesticide dealers. Permethrin (Pounce 3.2 EC and Ambush 2 EC) is cleared for use on avocados. See label for specific instructions.
Mirids

A number of species of small, sucking insects known as mirids (*Daghbertus fasciatus*, *D. olivaceous*) feed and insert their eggs on opening buds, leaves, flowers and small fruit. Attacks seem to affect especially flowers and recently-set fruit, causing them to drop. Wounds on fruit may serve as a point of entry for decay organisms. These insects are comparatively small, about an inch in length, and their nymphs can pass through several instars, during which the size increases greatly. Color patterns change from a variety of green and brown. Mirids usually appear during bloom and early fruit-setting stage. It is suggested that weeds and grass in and around the grove be mowed as closely as practicable in order to reduce harboring places for mirids. Mirid populations are most common from January through April, when avocado flowers are fully open.
Monitoring and Action Levels
If excessive flower drop is observed and coincides with numbers higher than 30 mirids per panicle, chemical control might be warranted.

Control
Malathion is the material that can be used on avocados and is most likely to have controlling effects on mirids. During flowering, spray applications should be applied in later afternoon to reduce losses of honey bees.

Scales
Several kinds of scales, including latania, pyriform, Florida red, dictyospermum and Floridawax, may infest avocado. Check for scales and, if needed, apply control measures during May, June or July.

Aspidiotus destructor an armored scale, infesting avocado leaves

Control
Apply one of the following in 100 gallons of water: (1) 4-5 quarts of 90-92 percent oil emulsion concentrate; (2) 1 1/2 pints of malathion 5 liquid; (3) 3 quarts of 90-92 percent oil concentrate plus 1 pint of malathion 5 liquid; (4) 2.5 fl oz per gallon of insecticidal soap (this last option is probably safest). When applying Permethrin (Pounce) on scale crawlers, use 8 oz of 3.2 EC per acre.

Spider Mites, Oligonychus yothersi (McGregor)
The avocado red mite is a common pest of avocados in Florida. Feeding is first confined to the upper surface of avocado leaves; it is found first along the midrib, then along secondary leaf veins. The areas along the veins become reddish-brown. During heavy infestations, leaves can be covered with mites’ cast skins. Damage to the leaf area is regularly observed from October through March, causing up to 30% reduction of photosynthetic activity of the leaves. Leaves affected by this mite regularly drop earlier (45-60 days after infestation) than
leaves that have not been infested. This mite is an occasional pest in some orchards and is seldom observed in others. Periodic inspections are recommended during December, January and February. Control measures may be started when the population reaches 6 or more mites per leaf.

**Life Cycle**
The eggs are spherical and stalked. Adults have a pinkish color, with their middle area covered by many purplish-brown blotches. The duration of the life stages varies from 14 to 15 days. Females are capable of laying 40 to 50 eggs during their life span.

**Monitoring and Action Levels**
Select 10 trees at random. Observe damage and mite densities using Hand lens. If higher damage is observed near borders or roads and not in the entire grove, apply control only to the first 3 rows. For young trees showing more than 60% bronzing to the leaf area or if the damage is uniform throughout the grove, apply control.
Control
Few miticides are registered for use on avocados when fruit is present. Apply sulfur dust or spray with sulfur using 10 pounds of wettable sulfur per 100 gallons of water, or use oil emulsion sprays made by mixing 3 quarts of 90-92 percent oil concentrate per 100 gallons of water and apply thoroughly. Also see instructions on labels for various brands of oil. Pyrellin (pyrethrins + rotenone) is registered at 1-2 pts/A.

Thrips

Red-banded thrips feed on leaves and fruit. Infested leaves are spotted on the upper surface, with dark, reddish-brown fecal pellets. Heavy feeding on fruit causes a russetted appearance, cracking and decay. Greenhouse thrips damage fruit and tend to feed on the larger and more mature fruit. They are found most frequently where two fruits are in contact or where a leaf contacts the fruit. Fruits are damaged by slight russetting, then by cracks followed by decay.

Monitoring and Action Levels
Check leaves and fruit for red-banded thrips during summer and fall for any developing infestation. Frequent inspections of fruit are recommended for greenhouse thrips beginning in early August and continuing until fruit harvest. The following materials are labelled for use against thrips: malathion (various labels), permethrin (Pounce, Ambush), pyrethrins + rotenone (Pyrellin).

Full-grown larva of the red-banded thrips on avocado: Flower Thrips, *Frankliniella kelliae* and *Frankliniella bispinosa*
Flower thrips are yellowish, about 1.5 mm long, with yellowish legs and two pairs of wings fringed with narrow hairs. Larvae are pale yellow. The small eggs are laid singly in the panicle or fruit tissue. They hatch into larvae which are almost transparent. The complete life cycle takes around 4-5 weeks. These thrips are present during the dry season and are noticeable when flowering starts; infestations can be in huge numbers, causing excessive flower drop or fruit deformation. Infestations on avocado are usually the result of adult thrips invading abruptly and in very large numbers from a large number of hosts, such as mango, litchi and a range of subtropical fruits and other flowering plants. Sampling for thrips requires beating at least 10 panicles selected at random or hanging sticky traps from the tree canopy. The economic threshold for thrip control is unknown.

**Action Levels**

If excessive flower drop is observed and coincides with numbers higher than 100 thrips per panicle, chemical control might be warranted.
**Avocado Bud Mite, *Tegolophus perseaflorae* (K.)**

The avocado bud mite is regularly found on buds, but also feeding on developing fruit. The mites cause necrotic spots—subcircular, irregular openings on apical leaves. Feeding by this mite may cause fruit deformation and discoloration. The adult avocado bud mite has a yellowish appearance. Its life cycle has not been determined. Avocado bud mite populations begin to increase from March to May.

The eriophyid mite, *Tegolophus perseaflorae* in avocado buds

Necrosis caused by the eriophyid mite on buds and newly expanded leaves
Random holes on older leaves are the result of feeding of T. perseflorae on unopened buds

**Avocado Lace Bug, *Pseudacysta perseae***

The avocado lace bug was considered a minor pest of avocados until severe outbreaks were observed during the 1990’s. The adults (Figure 16) are oblong shaped, brownish with numerous, small “lace-like cells” in the thorax and wings; they are observed on the leaf underside, where they feed, extracting juices from the plant. They usually live in colonies, depositing eggs in irregular rows in clusters on the lower-leaf surface. The eggs are covered with a dark, sticky secretion from the adults. The extraction of juices from the foliage causes a gradual localized destruction of the plant cells. The resulting chlorotic areas will become brown (Figure 17), and they are an indication of the presence of the lace bugs. Lace bugs begin a steady build-up in January and March.
**Action Levels**

Presence of the avocado lace bug and damage of more than 30% to the foliage would merit application of pesticides. The pesticide M-Pede (soap) provides control of the avocado lace bug.

![Avocado tree with 40% to 60% damaged by avocado lace bug](image)

**Ambrosia Beetles**

Ambrosia beetles, *Xylosandrus* sp., burrow into tree trunks, stems and branches. Infested trees are regularly stressed before the attack, but frequently the trees appear to be healthy and vigorous. Fungi accompany the beetles and develop mycelia in tree tissues, which constricts branches and trees. As a result, the portion of the tree terminal to the burrow entrance usually dies. White crystals of sap about the burrow entrances are evidence of infestation. Beetles are brownish to almost black and small, about 1/50 inch in diameter and 1/20 inch long. Eggs and beetle larvae are white and found in the galleries. Larvae feed on the mycelia of "ambrosia" fungi growing in the galleries.
Adults of Ambrosia beetles

Frass exuding from avocado trunks infested with ambrosia beetles

Developed by Jorge Pena, Tropical Research and Education Center, University of Florida, Homestead, Florida.
Disease Management of Avocado

Many diseases are known to affect the avocado tree, leaves, flowers, and fruit. The following is a description of diseases found to be most economically important for South Florida avocado growers. Diagnostic symptoms with pictures and management recommendations are included.

Without following proper control recommendations, these diseases can result in significant loss to both quality and quantity of avocado yield.

- Phytophthora root rot
- Anthracnose
- Cercospora spot/blotch
- Avocado scab
- Powdery mildew

Description of Disease: Phytophthora Root Rot

Phytophthora root rot is the most important disease of avocado, and the limiting factor for production in many regions throughout the world.

*Phytophthora cinnamomi* Rands attacks and rapidly kills avocado roots in poorly drained soil. Areas with less than 10-foot elevation get high ground water during the rainy season, which favors the pathogen. Severely infected trees show sparse foliage with pale green, often wilted leaves, and dieback occurs in advanced stages. Feeder roots become blackened and decayed, and may be almost entirely absent in advanced stages of the disease.

Severely infected trees with sparse foliage, wilted leaves and dieback caused by *Phytophthora cinnamomi*
Management Recommendations
Be certain to choose only disease-free nursery stock. Do not plant in areas that are subject to flooding. Avoid the introduction of soil or water from infested areas to clean fields on equipment or plant stock. For chemical control, use one of the following pesticides according to the manufacturer’s label:

- Aluminum phosphonate salt (Aliette)
  - be certain not to mix with copper
- Phosphorous acid or Potassium phosphite (Fosphite; Helena Prophyt; Agri-Fos)
  - for best results, apply when the leaves are hardening off (e.g., during May in South Florida)
- Mefenoxam (Ridomil Gold EC)

Description of Disease: Anthracnose

Anthracnose (black spot) is the most common rot of mature fruit, but also affects leaves and young fruit.

*Colletotrichum gloeosporioides* Penx., which lives as a saprophyte or weak parasite on numerous plants in Florida. The fungus is considered a weakly aggressive pathogen found growing on dead or dying leaves, twigs and fruit surface. Infection occurs as fruit ripens and latent infection on fruit can be a problem when the fruit starts to soften if it goes untreated. The fungus infects wounds, rind cracks, or lesions caused by *Pseudocercospora*. Infections are slightly sunken and nearly circular, dark brown to black and vary from tiny to 2 inches in diameter. Spore masses appear pinkish orange when active.

Severe symptoms of anthracnose on leaves and fruit
The salmon-colored spores of *Colletotrichum gloeosporioides* oozing from the black lesions.
Management Recommendations
Wind- and insect-damaged fruit should definitely be treated with copper or azoxystrobin to prevent infections from the fungus. On late maturing varieties—such as Nabal, Taylor, and Choquette—a fall application of fungicide is recommended.

Description of Disease: Pseudocercospora Spot/Blotch

Pseudocercospora spot/blotch is a disease of warm, humid, and rainy climates and, as a result, it is a common problem on avocado in South Florida.

_Pseudocercospora purpurea_ (Cook) Deighton causes leaf spots that are angular in shape, 1/16 inch in diameter, brown-to-chocolate indistinct, and scattered, though often coalescing to patches. Grayish spore-bearing tufts on either leaf surface are present during moist conditions. On fruit, spots are 1/4 of an inch or less in diameter, irregular in shape and slightly sunken. The fruit surface sometimes becomes cracked or fissured. The fungus is carried over on old leaf infections and can get more severe if no control measures are taken. Critical infection periods are May through July, but can go to September. Damage is limited to the rind, but as the rind cracks other invaders move in.

Symptoms of _Pseudocercospora purpurea_ on fruit and leaves
The leaf spots are brown, angular in shape, and scattered; the fruit spots are dark brown to black, irregular in shape and slightly sunken.

Management recommendations
Pseudocercospora is controlled readily by timely applications of copper or azoxystrobin sprays. Be careful to cover both foliage and fruit. Application in early May and June gives effective control on varieties maturing in summer and fall. A third application is recommended in mid July for winter-maturing varieties.
Description of Disease: Avocado Scab

Avocado scab can be a serious problem in South Florida, as a result of fruit drop and lowered market value of affected fruit.

*Sphaceloma perseae* Jenk. is carried over one season to the next on leaf and stem lesions. When moisture and temperature are favorable, the fungus readily infects young, succulent tissues of avocado leaves, twigs, and fruits, forming the characteristic scab lesions in which spores are produced. These spores are readily spread through the grove by wind, rain, dew, and most likely insects. Young leaves are susceptible, but become resistant once they mature and the tissues become more hardened. Fruits are extremely susceptible just after the petals fall and become more resistant as they develop. Individual spots on leaves are purplish to dark brown, fading to grayish brown with age. They are visible on both surfaces and often the center weathers away to leave small, irregular holes. Infection on the underside of leaves is confined mainly to the midrib and veins. On fruits, the spots are at first raised, circular to oval, and dark brown to purplish brown. They are scattered, but many coalesce to form irregular extended areas that often cover the entire fruit surface. Eating quality is not impacted, but under severe infection the fruit is very unattractive. Varieties vary in susceptibility to scab. Lula is the most susceptible commercial variety. Fuschsia, Pollock, Booth 1 and Waldin are quite resistant.

A close-up of scab symptoms on fruit and entire fruit surface covered with symptoms of scab caused by *Sphaceloma perseae.*

The raised, circular to oval, and dark brown to purplish brown spots that appear scattered.

Management recommendations
Copper fungicides seem to give good control and Folpet is also labeled for controlling avocado scab. The *Pseudocercospora* spray program works for scab, but if you’re growing Lula it requires 3 additional sprays timed as follows: just as the bloom bud opens (late January); near the end of the main bloom period (mid February-March); and 3-4 weeks after all the fruit have set in a normal season.
**Description of Disease: Powdery Mildew**

Powdery mildew is considered by most to be a minor disease problem, but too often it becomes serious enough to warrant chemical sprays.

*Oidium* sp. frequently occurs on avocado foliage. It can become serious on untreated trees if favorable conditions persist. Infections on young leaves appear as dark green areas with a powdery, white, spore-bearing growth on the undersides. Underside of infected areas on mature leaves is generally purplish brown and covered with white, powdery growth. The upper side of leaves has a yellowish-green discoloration.

![Symptoms of powdery mildew on leaf](image)

The chlorotic (yellow) spots on the upper side of the leaf and powdery growth of an *Oidium* sp. on the underside causing necrosis (dead tissue).

**Management recommendations**

Be certain to scout trees for symptoms when conditions are cool and humid, especially during early spring in South Florida. For chemical control, apply sulfur fungicides according to the manufacturer’s label.

**Additional information**

Pesticides labeled for Avocado- [http://crane.ifas.ufl.edu](http://crane.ifas.ufl.edu)

Florida Extension Plant Diagnostic Clinic- [http://trecclinic.ifas.ufl.edu](http://trecclinic.ifas.ufl.edu)

Additional Pesticide info can be found at CDMS- [http://www.cdms.net/manuf/manuf.asp](http://www.cdms.net/manuf/manuf.asp)

Developed by Aaron Palmateer, Tropical Research and Education Center, University of Florida, Homestead, Florida.
Site selection for avocado groves

Site selection for avocado groves outline
1. Soils
2. Elevation
   a. Surface water
   b. Ground water
3. Bedding and mounding
4. Row orientation
5. Wind breaks

Soil characteristics of the production area of South Florida

Krome
1. 0-7 inches very gravelly loam
2. 7+ inches weathered bedrock
3. 15-20% clay at 0-7 inches
4. Permeability (drainage fast)
5. 0-7 inches, 0.6-2.0 in/hr
6. 7+ inches, 2.0-20 in/hr
7. Water holding capacity
8. 0.08-0.12 inches/inch
9. Soil pH, 7.4-8.4
10. 3-10% organic matter
11. On average the water table is at 40-60 inches below the soil surface.

Chekika
1. 0-5 inches very gravelly loam
2. 5+ inches weathered bedrock
3. 15-20% clay at 0-5 inches
4. Permeability (drainage fast)
5. 0-5 inches, 0.6-2.0 in/hr
6. 5+ inches, 2.0-20 in/hr
7. Water holding capacity
8. 0.08-0.12 inches/inch
9. Soil pH, 7.4-8.4
10. 3-10% organic matter
11. On average the water table is at 12-36 inches below the soil surface.
12. Generally found in lower elevation areas (west and south).

Soils and elevation
- In our area the surface and ground water are one in the same (i.e., connected).
- Drainage depends upon depth to water table and varies with management and rainfall.
- Permeability is generally good if the water table is lowered.
Recommendations:
  - Plant in areas with elevations 7 ft and above; higher is better.
Avocado groves already subjected to flooding and tree damage/death should be avoided or strongly considered for planting of another crop (e.g., mango, guava) or other use.

**Low areas with potential for flooding**
- In general, avocado trees are intolerant of excessively wet or flooded soil conditions.
- Presence of *Phytophthora cinnamomi* (root rot) in conjunction with wet soil conditions causes a rapid decline/death of the trees.
- Symptoms include:
  - Leaf and stem wilting
  - Leaf curling, drying, browning (death)
  - Leaf drop
  - Fruit shriveling and drop
  - Tree dieback to tree death
  - Declining trees may put out repeated weak new shoots and leaves and continue to slowly dieback.

**Recommendations for slightly low areas**
1. Fill in with native rock material (if economically feasible).
2. Form 3 to 5 ft high and 6 ft wide beds.
3. Form individual mounds of 3 to 5 ft high and 6 ft in diameter.

**Tree row orientation**
1. In general, north-south rows are advantageous for maximum light exposure.
2. However, if the property is longer in the east-west dimension, then rows should be in an east-west direction for maximum efficiency in grove operations.

**Wind breaks**
**Positives**
1. Affords some wind protection to trees (especially young trees).
2. There may be some early tree growth response.

**Negatives**
1. Takes up land area.
2. Roots may be invasive and compete with avocado trees for nutrients and water.
3. Wind break trees will compete for light with avocado trees adjacent to them.
4. Trees may topple into the avocado grove, causing additional storm damage to trees and the irrigation system.

**Summary**
1. The most important site selection consideration is land elevation—higher is better. Lowlands <7 ft should be avoided if possible.
2. Bedding or mounding may improve plant survival in some slightly marginal areas, i.e., only slightly low.
3. North-south row orientation is best.
4. Temporary wind breaks may be of some benefit for young tree growth.
Avocado cultivar selection

Considerations in selecting an avocado cultivar

1. Production (yield): Inherent predisposition for high yields of good quality fruit.
2. Flower type (A or B): Cultivars with known flower behavior allow for optimizing the layout of A-and B-type avocado cultivars and subsequent high yields.
3. Season: Florida has early, mid- and late-season cultivars; each season has its advantages and disadvantages.
4. Fruit quality: Selection of high-quality cultivars is necessary for optimizing marketing of Florida avocados. Quality parameters include:
   a. Size: Florida is known for production of high-quality large fruit in contrast to the very small ‘Hass’ types which predominate in most other production areas.
   b. Shape: Influences packing characteristics and cultivar identification.
   c. Eating characteristics are a conglomerate of color, texture, olfactory, and flavor.
5. Storage life and shipping characteristics influence harvest through postharvest handling. Cultivars with tolerant handling characteristics (e.g., rough handling), high disease resistance postharvest, long storage tolerance, and even ripening are best.
6. Disease resistance in the grove and during storage enhances marketability.
7. Marketability characteristics include season of availability, fruit quality, and storage and shipping characteristics.

Suggested early season cultivars

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<tr>
<th>Cultivar</th>
<th>Yield¹</th>
<th>Flower type</th>
<th>Size²/rating</th>
<th>Shape</th>
<th>EC³</th>
<th>Disease rating, C/S⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dupuis</td>
<td>L-M</td>
<td>A</td>
<td>M-L/ good</td>
<td>Attractive, obovate</td>
<td>E</td>
<td>R/R</td>
</tr>
<tr>
<td>Simmonds</td>
<td>H</td>
<td>A</td>
<td>M-L/ good</td>
<td>Attractive, obovate to slightly pyriform</td>
<td>G-E</td>
<td>R/R</td>
</tr>
<tr>
<td>Donnie</td>
<td>M-H</td>
<td>A</td>
<td>L/ good</td>
<td>Attractive, oval to obovate</td>
<td>G</td>
<td>R/R</td>
</tr>
<tr>
<td>Bernecker</td>
<td>H-VH</td>
<td>A</td>
<td>M-L/ good</td>
<td>Attractive, oval to obovate</td>
<td>G-E</td>
<td>R/R</td>
</tr>
<tr>
<td>Miguel</td>
<td>VH</td>
<td>B</td>
<td>M-L/ good</td>
<td>Attractive, oval to obovate</td>
<td>G-E</td>
<td>MS/R</td>
</tr>
<tr>
<td>Nesbitt</td>
<td>H</td>
<td>A</td>
<td>M-L/ good</td>
<td>Attractive, obovate to slightly pyriform</td>
<td>G</td>
<td>R/R</td>
</tr>
</tbody>
</table>

1. Yield: L, low; M, moderate; H, high; VH, very high.
2. Size: S, small; M, medium; L, large; VL, very large.
3. EC, eating characteristics; E, excellent; G, good; F, fair.
4. Psuedocercospera/scab resistance; R, resistant; S, susceptible; MS, moderately susceptible.

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### Suggested mid-season cultivars

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Yield¹</th>
<th>Flower type</th>
<th>Size²/rating</th>
<th>Shape</th>
<th>EC³</th>
<th>Disease rating, C/S⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta</td>
<td>VH</td>
<td>B</td>
<td>M-L</td>
<td>Attractive, oval to obovate</td>
<td>G</td>
<td>R/R</td>
</tr>
<tr>
<td>Melendez</td>
<td>H</td>
<td>B</td>
<td>L</td>
<td>Attractive, oblong to pyriform</td>
<td>E</td>
<td>- /R</td>
</tr>
<tr>
<td>Semil 34</td>
<td>H</td>
<td>A</td>
<td>M</td>
<td>Attractive, slightly pyriform</td>
<td>G-E</td>
<td>- /R</td>
</tr>
<tr>
<td>Semil 43</td>
<td>H</td>
<td>B</td>
<td>M</td>
<td>Attractive, oblong</td>
<td>G-E</td>
<td>- /R</td>
</tr>
</tbody>
</table>

1. Yield: L, low; M, moderate; H, high; VH, very high.
2. Size: S, small; M, medium; L, large; VL, very large.
3. EC, eating characteristics; E, excellent; G, good; F, fair.
4. Psuedocercospera/scab resistance; R, resistant; S, susceptible; MS, moderately susceptible.

### Suggested late-season cultivars

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Yield¹</th>
<th>Flower type</th>
<th>Size²/rating</th>
<th>Shape</th>
<th>EC³</th>
<th>Disease rating, C/S⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monroe</td>
<td>H</td>
<td>B</td>
<td>L/good</td>
<td>Attractive, oval</td>
<td>E</td>
<td>S/MR</td>
</tr>
<tr>
<td>Choquette</td>
<td>M-H</td>
<td>A</td>
<td>L/good</td>
<td>Attractive, oval</td>
<td>G-E</td>
<td>S/MR</td>
</tr>
</tbody>
</table>

1. Yield: L, low; M, moderate; H, high; VH, very high.
2. Size: S, small; M, medium; L, large; VL, very large.
3. EC, eating characteristics; E, excellent; G, good; F, fair.
4. Psuedocercospera/scab resistance; R, resistant; S, susceptible; MS, moderately susceptible.
### Suggested niche market cultivars

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Yield¹</th>
<th>Flower type</th>
<th>Size²/rating</th>
<th>Shape</th>
<th>EC³</th>
<th>Disease rating, C/S⁴</th>
<th>Cultivar Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russell</td>
<td>H</td>
<td>A</td>
<td>L/ good</td>
<td>Curiosity, elongated pyriform</td>
<td>G</td>
<td>R/R</td>
<td>Difficult to pack; good price in ethnic market</td>
</tr>
<tr>
<td>Catalina</td>
<td>L-M</td>
<td>A</td>
<td>L/ good</td>
<td>Attractive, obovate to pyriform</td>
<td>E</td>
<td>R/R</td>
<td>Low yields; good price in ethnic market.</td>
</tr>
</tbody>
</table>

1. Yield: L, low; M, moderate; H, high; VH, very high.
2. Size: S, small; M, medium; L, large; VL, very large.
3. EC, eating characteristics; E, excellent; G, good; F, fair.
4. Psuedocercospora/scab resistance; R, resistant; S, susceptible; MS, moderately susceptible.
5. No commercial experience.

### Potential very-late-season cultivars

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Yield¹</th>
<th>Flower type</th>
<th>Size²/rating</th>
<th>Shape</th>
<th>EC³</th>
<th>Disease rating, C/S⁴</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfa²</td>
<td>L-M?</td>
<td>A</td>
<td>M-L</td>
<td>Attractive, ovate to obovate</td>
<td>E</td>
<td>R/R</td>
<td>Very late season: March-April.</td>
</tr>
<tr>
<td>April⁵</td>
<td>H</td>
<td>B</td>
<td>M-L</td>
<td>Attractive, obovate</td>
<td>E</td>
<td>R/R</td>
<td>Very late season: March-April.</td>
</tr>
</tbody>
</table>

1. Yield: L, low; M, moderate; H, high; VH, very high.
2. Size: S, small; M, medium; L, large; VL, very large.
3. EC, eating characteristics; E, excellent; G, good; F, fair.
4. Psuedocercospora/scab resistance; R, resistant; S, susceptible; MS, moderately susceptible.
5. No commercial experience.
Flowering types and pollination: “A” and “B” type avocados

Complementary, synchronous dichogamy. Interplanting A and B type avocado cultivars is necessary for optimum fruit production of many cultivars. A few cultivars—such as ‘Taylor,’ ‘Waldin’ and ‘Lula’—do not appear to need cross pollination to be productive (these cultivars are not recommended for commercial planting).

- Individual avocado flowers open twice over a 2-day period—first functionally as female, and second as functionally male.
- Each avocado cultivar or seedling displays a consistent pattern to their sequence of female and male opening.
- Avocados are insect pollinated (bees, flies).
- However, there is some evidence that under certain environmental conditions (warm, subtropical) some cultivars (WI types) are wind pollinated.
- Cool temperatures can result in overlapping of female/male opening.
- Cool nights with warm, overcast days may result in overlapping.
- High temperatures may reduce the length of the flowering cycle.

Pollination

- Generally, complementary flower types are inter-planted to “improve” fruit set and crop yields.
- For example, with ‘Dupuis’ (A) it has been observed that yields improve when it is planted with ‘Hardee,’ ‘Beta,’ and ‘Miguel’ as B-type pollinators.

Advantages of early-season cultivars

- Historically higher prices during this time, due to fewer avocados in the market.
- Lower fruit production maintenance costs because of fewer spray applications than mid- and late season cultivars.
- Early season harvest usually avoids hurricane season and its potential to defruit trees and cause fruit damage.
- Many early season cultivars have good disease resistance.
- Tree size control optimum because they may be topped and hedged early, allowing the tree to vegetatively recover and bloom the following spring.

Advantages of mid- and late-season cultivars

- Market continuity: continuous Florida fruit in the marketplace.
- Most mid- and late-season avocados are good-quality Florida avocados.
- Potential for very early spring (very late cultivars) Florida fruit in the market, which would receive higher prices.

Disadvantages of mid- and late-season cultivars

- More fungicide applications and higher fungicide costs.
- Potential loss of fruit due to tropical storms or hurricanes.
- Potential cold/freezing damage.
Historically, prices are lower unless for very late cultivars.
Tree size management may be more difficult because pruning in late fall and winter causes trees to potentially remain vegetative the following spring and not flower and fruit.

Advantages of niche market cultivars
- Good to high quality cultivars.
- Usually command higher prices than common cultivars.
- Potentially less competition because they are targeting a direct demand niche.
- Potential good prices for very late (March/April) avocados.

Disadvantages of niche market cultivars
- Potentially moderate to low yields of some of these cultivars.
- Must find and maintain specialty markets.
- Potential for overplanting, with subsequent reduction in prices.

Summary
- Florida grows numerous cultivars of avocado. This sometimes makes identification of a Florida-produced avocado difficult.
- Quality of Florida cultivars varies, and planting of improved cultivars is warranted.
- Perhaps one more mid-season and a few improved late and very late or very early season types may be advantageous to the industry.
- Florida is known for its large avocados, and this identity should be maintained to differentiate Florida from the ‘Hass’ market.

Plant spacing and tree size control

Factors to consider with plant spacing

Established groves
1. Climate: The warmer the climate and the longer temperatures allow vegetative growth, the greater the vegetative growth and potential for decreased flowering and crop yields.
2. Current irrigation system setup may interfere with optimum plant spacings and either the irrigation system will need modification or adjustments need to be made to the proposed plant spacing.
3. Cultivar growth, habit and vigor. Some cultivars are more vigorous than others and grow more vegetatively in response to pruning (e.g., ‘Lula’ vs. ‘Booth-8’).
4. Size of equipment and ease of movement. In general, 6 to 8 ft row middle is required for efficient movement of grove equipment and harvest.
5. Mechanical and/or hand pruning program. Hand pruning may allow slightly narrower plant spacings than use of mechanical pruners. Intensity (size of wood cut) and frequency (yearly, bi- or tri-yearly) of the pruning program will influence subsequent crop yields. Closer plant spacings generally require more frequent or intense pruning than wider plant spacings.
6. Want to achieve ultimate tree size desired or that is feasible and still maintain production. Some cultivars may be more adaptable to smaller tree sizes and plant spacings than others.
7. Life expectancy of the grove. Groves planted with a purpose or removal in 10 to 15 years may be planted more closely than groves planted with the intention of 15+ year life span.
8. Effect on light exposure. The more closely planted a grove is, the sooner competition for light among trees occurs. Therefore, wider between-row spacings and moderate in-row spacings are more desirable than close between-row spacings.

Proposed groves
1. Climate: Same as above.
2. Proposed irrigation infrastructure/layout: There is an opportunity to match the irrigation system(s) to the plant spacing when establishing new groves.
3. Cultivar growth habit and vigor should be taken into account when deciding plant spacing of new groves.
4. Size of equipment: Same as above.
5. Proposed mechanical and/or hand pruning program. Same as above.
6. Ultimate tree size desired: Same as above.
7. Life expectancy of the grove. If business planning allows for projection of the grove’s life, this may allow closer spacings to be utilized or configured for optional widening in the future.
8. Effect on light exposure. In addition to plant spacing, configuration of the planting such as a diamond pattern or a pattern that allows for eventual removal of some trees may be made when establishing new groves.
Climate and plant spacing
In South Florida’s humid, subtropical climate of relatively warm to hot temperatures and abundant rainfall from April through October, avocado trees have 2 to 3 potential vegetative flushes:

- After flowering and during fruit set
- During the summer (summer flush)
- After pruning

Thus, there is potential for a substantial increase in the canopy size each year.

Other factors which influence plant spacing
1. During the late fall/winter, tree growth slows or stops, thus reducing the chances for fall/winter flushing. Similarly, dry soil conditions (usually fall/winter/early spring) also limit tree growth.
2. Potential freezing conditions occur from Nov. through Feb., therefore tree size control is important for cold protection practices with high-volume irrigation.
3. From June through November, we have the potential for tropical storms and/or hurricanes—thus a potential for tree damage, toppling, and uprooting; therefore, tree spacing and its effect on tree size and canopy management are critical to minimize the effect of high winds.

Irrigation infrastructure

Established avocado grove
1. With an established high volume overhead or under-tree irrigation system, close plant spacing may interfere with the wetting pattern and negatively affect cold protection practices.
2. The irrigation system may need to be modified to accommodate the desired spacing, thus adding cost to using the system.
3. Plant spacing may affect the irrigation rate and frequency necessary for optimum fruit production.

Re-established grove*
The established irrigation system may:

- restrict or dictate the plant spacing options.
- interfere with movement of grove equipment.
- need to be modified to accommodate the desired spacing, thus adding cost to using the system.
- result in utilizing an undesirable plant spacing and result in excessive tree competition and tree pruning.

*The grove was planted to a different fruit crop previously.
Proposed new groves
1. There is an opportunity to design the irrigation system to the spacing desired.
2. For cold protection, the high volume system should be designed to completely cover (with overlap) the grove.
3. For irrigation and fertigation, a low-volume system may be designed to reduce energy costs and improve irrigation efficiency.

Cultivar growth habit and vigor
1. Upright vigorous growth habit -
   a. ‘Lula’ (not recommended for planting)
2. Moderately upright -
   a. ‘Dupuis’
   b. ‘Monroe’
3. Spreading growth habit -
   a. ‘Bernecker’
   b. ‘Beta’
   c. ‘Catalina’
   d. ‘Choquette’
   e. ‘Donnie’
   f. ‘Simmonds’
   g. ‘Marcus’
   h. ‘Melendez’
   i. ‘Miguel’
   j. ‘Nesbitt’
   k. ‘Russell’
   l. ‘Semil 34’
   m. ‘Semil 43’

Effect of light exposure on photosynthesis (sugar/nutrient production)
Adequate light is required for:
- Maintenance and retaining lower productive tree canopy.
- Flower production, fruit set and fruit development.
- Stimulating new shoots and fruiting wood within the lower areas of the tree.

Plant spacing in Florida
1. A general rule of thumb is that the tree height should not be allowed to be more than two times the drive middle spacing. For example:
   a. for an 8 ft drive middle, the tree height should not exceed 16 ft.
   b. for a 6 ft drive middle, the tree height should not exceed 12 ft.
2. Range in plant spacings found: 15 to 25 ft in-row; 24 to 25 ft between-row.
3. Recommended: 20 to 25 ft in-row and 25 ft between rows.
Plant spacing and tree density in Florida

<table>
<thead>
<tr>
<th>In-row spacing (ft)</th>
<th>Between-row Spacing (ft)</th>
<th>No. trees per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>25</td>
<td>69</td>
</tr>
<tr>
<td>24</td>
<td>25</td>
<td>72</td>
</tr>
<tr>
<td>22</td>
<td>25</td>
<td>79</td>
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<tr>
<td>20</td>
<td>25</td>
<td>87</td>
</tr>
<tr>
<td>18</td>
<td>25</td>
<td>96</td>
</tr>
<tr>
<td>15</td>
<td>25</td>
<td>116</td>
</tr>
</tbody>
</table>

Close plant spacing

Advantages
- More efficient light interception on a per acre basis and higher production per acre during the first 5-6 years or more.
- More efficient use of fertilizers, pesticides, and irrigation, which is based on a per acre basis.
- Faster canopy closure and reduced weed pressure.
- After a hurricane, potentially more trees remaining.
- Potential faster return on investment.

Disadvantages
- Increased cost of trees (more trees), angering, and microsprinklers.
- Earlier and increased competition for light, nutrients, and water among plants.
- Potentially, tree size management more critical and difficult, must start earlier, and potential for higher cost.

Moderate to wide spacing

Advantages
- Decreased cost of trees (fewer trees), angering, and microsprinklers.
- Less competition for light, nutrients, and water among plants.
- Tree size management less critical and less difficult (up to a point), and may be delayed slightly.
Disadvantages

- Less efficient light interception on a per acre basis, and lower production per acre during the first 5-6 years.
- Less efficient use of fertilizers, pesticides, and irrigation, which is based on a per acre basis.
- Slower canopy closure and more prolonged weed pressure.
- Potential slower return on investment.

Avocado growth habit

- Architecturally, avocado is a polyaxial species with a synchronous growth pattern characterized by alternating root and shoot growth and vegetative and reproductive growth separated in time.
- Fruit generally held on the outer 3-5 ft of canopy.

1. Tree training and tree size control

- Training of young trees is not common but is important, especially in close spacings. Heading back to force lateral development and removal of misplaced and V-crotched limbs will reduce problems later.
- Tree size control may be maintained by hand pruning and/or mechanical machinery (more common).
- Suggested tree size (14 to 16 ft) varies with environment, plant spacing, available technology, frequency of hurricanes, and cultivar growth habit and harvest season.
- Reasons for tree size control: maintain light levels and lower productive canopy, improve crop production by increasing the number of shoots, increase air movement through the canopy and therefore reduce disease incidence, facilitate grove traffic, and reduce the potential for hurricane damage.

2. Tree training and tree size control

- In general, the warmer the climate, the more vigorous the tree growth.
- In general, for terminally bearing species, pruning of large diameter stems/wood results in excessive and continuous vegetative flushing.
- The wider the spacing, the longer it takes to require regular pruning. The closer the plant spacing, the earlier a pruning program is required and the more frequently trees are pruned.
- In general, designing a pruning program for closely spaced trees is more difficult than for more moderately spaced trees, because of the amount of wood necessary to remove during the pruning process.
- In general, designing a pruning program for cultivars with a vigorous, upright growth habit is more difficult than for less vigorous, spreading growth habit cultivars.
- Recommendation for Florida: top trees to 14-16 ft and maintain a 6-8 ft middle.
- Recommendation for Florida: hedge trees at a 5 to 10 degree angle (wider at the bottom).
3. Tree training and tree size control

- There is more (and sufficient) time for early-season cultivars pruned immediately after harvest to mature the vegetative flushing after pruning than for mid- and late-season cultivars.
- Recommendation is cultivar dependent: prune early-season cultivars immediately after harvest (some mid-season cultivars too), and for mid- and late-season cultivars design a program of periodic pruning, e.g., every third row canopy side every third year, top every third year.
- Selective pruning to thin out inner canopy limbs will increase light penetration, help maintain the lower productive canopy, may re-establish production on the inside lower areas of the tree, and improve air movement to reduce fruit/leaf disease problems.

Advantages to tree size control and maintenance

- Maintained and/or increased light levels along the entire canopy and thus potential for greater fruit production.
- Increased and/or maintained light exposure to the lower and inner tree canopy with potential for increased fruit production.
- Improved foliar spray penetration: improved nutrient and fungicide efficacy.
- Increased disease control.
- Decreased wind resistance and potential damage from strong winds. Allows wind to move through the canopy and not push the tree over.
- Improved high volume irrigation cold protection: better coverage of the entire tree canopy.
- Increased ease and efficiency of harvest. Reduced time and effort in harvesting.

Hedging angle and topping options

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Selective pruning

1. Selectively remove secondary limbs back to their origin to limit tree height and spread.
2. Open up the inner canopy to maintain or increase light penetration within the canopy.
3. Again, the idea is to slightly taper the canopy to increase light levels and maintain a lower and inner canopy.

Tree size control and maintenance

Selective pruning and rejuvenation of the inner and lower canopy

- Maintenance of the lower tree canopy depends upon the tree height, light intensity and number of hours of light per day, and number of days of light exposure.
Rejuvenation of inner/lower canopy

1. Purpose: to re-establish fruit production through re-establishing a “new,” lower canopy and smaller tree.
2. Entails severe cutting back to major limbs (hatracking) or to a stump with or without “nurse” limb.
3. Crop production begins in 2-4 years depending upon cultivar. However, with nurse limb some production is maintained.

Hurricanes and avocado tree size

A survey post Hurricane Andrew of 5 groves
- 2 to 80 acres in size
- 10 to 46 years old
- 15 to 25 ft in height prior to the storm

Found
1. 87% of the trees survived
   a. 10% toppled
   b. 10% stumped
   c. 67% standing
2. 13% of the trees destroyed
3. The percentage of standing trees increased with tree age and decreased with tree height.
Rejuvenating non-productive avocado groves

A 4 year avocado rejuvenation research project
34-year-old ‘Lula’ and ‘Booth 8’ trees
1. ‘Lula’ >40 ft tall; ‘Booth 8’ >25 ft tall
2. 20 ft x 20 ft spacing
3. Lower 1/3 to 2/3 canopy lost
4. <1 bu/tree yield (~108 bu/A)
5. ‘Booth 8’ trees were topped at 9’ (12’+TR), 16’+TR, 22’+TR, and 22’ (TR=every other tree removed). Treatments were applied in March.

Results for ‘Booth 8’.

<table>
<thead>
<tr>
<th>Trt*</th>
<th>Yield yr 2 (bu/A)</th>
<th>Yield yr 3 (bu/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9’ (12’+TR)</td>
<td>0</td>
<td>130</td>
</tr>
<tr>
<td>16’+TR</td>
<td>140</td>
<td>329</td>
</tr>
<tr>
<td>22’+TR</td>
<td>178</td>
<td>286</td>
</tr>
<tr>
<td>22’</td>
<td>119</td>
<td>130</td>
</tr>
</tbody>
</table>

*, Crop production resumes 18 months after pruning.

6. ‘Lula’ - Topped at 9’ (12’, 14’+TR), 11’ (16’+TR), 22’+TR, and 22’ (TR=every other tree removed). Treatments were applied in March.

Results for ‘Lula’.

<table>
<thead>
<tr>
<th>Trt*</th>
<th>Yield yr 3 (bu/A)</th>
<th>Yield yr 4 (bu/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9’ (12’, 14’+TR)</td>
<td>0</td>
<td>43</td>
</tr>
<tr>
<td>11’ (16’+TR)</td>
<td>0</td>
<td>86</td>
</tr>
<tr>
<td>22’ (22’+TR)</td>
<td>0</td>
<td>119</td>
</tr>
<tr>
<td>22’</td>
<td>0</td>
<td>108</td>
</tr>
</tbody>
</table>

*, Crop production resumes on the 4th year after treatments.
Economic analysis for ‘Booth 8’ found
  • Highest positive returns from 16’+TR and 22’+TR.

Economic analysis for ‘Lula’ found
  • Highest positive return from 22’ trt only.

Avocado crop production in Florida

1. Young trees begin to produce on a commercial scale after 3 to 4 years.
2. Historically, the recent industry average (all reported groves) has been ~200 bu/A or 110 lbs per tree. The range has been less than 55 lbs to close to 400 lbs per tree (~90 bu/A up to ~600 bu/A).
3. Yields from mature trees should average 110-165 lbs per tree; however, 275-385 lbs per tree are possible.
4. There is a biannual cycle of higher and lower (“on” and “off”) production years in Florida.

Summary

1. Plant spacing has a profound effect on tree size management strategies and potential crop yields.
2. Tree size management is necessary to maintain and/or improve crop production, improve the efficiency of foliar spray applications and fruit harvest, and reduce potential damage from high winds.
3. Tree size management may be done mechanically and/or by hand.
4. Rejuvenating non-productive groves should be conducted in stages and take into consideration the ultimate tree size management strategy to maintain production.

Quality management for Florida avocados

Introduction

In the past decade, the number of separate food items in produce departments has increased to well over 500, a reflection of the changing consumption patterns of American consumers. Tropical fruits are now commonly found in supermarkets from Atlanta to Omaha to Anchorage. Competition in produce departments, however, is intense due to the number of choices of products and the availability of products from other production areas. For these reasons, several commodity groups have initiated “value-added” programs in recent years to provide a differentiated product that the consumer can readily identify.

Successful programs have centered on identification of a “premium-quality” product. California growers have taken the lead in this area for many commodities, including stone fruits and avocados. For example, avocado growers initiated a “Ripe-tonight” program several years ago, which involved treating the avocados with ethylene gas to hasten ripening. The implementation of a premium-quality program involves careful coordination of all the steps from production through harvest, packing, cooling, and distribution operations. In order to be successful and develop consumer demand, the crop must consistently meet minimal acceptability standards.

Florida avocados can be marketed as a premium-quality product. Avocados are unique among fruits in that they do not begin to ripen until picked. However, this convenience creates difficulty in marketing avocados with uniform ripeness, since the fruits ripen at differing rates, depending upon the stage of maturation at harvest and variety.

Definitions

Horticultural Quality

Horticultural quality is assessed by those characteristics which consumers associate with a particular commodity, such as:

- Flavor/aroma
  - Sweetness (mango, strawberry)
  - Tartness
- Texture
  - creaminess (ripe avocado, canistel)
  - tenderness (snap beans, sweet corn)
  - crispness (carrots, celery)
  - juiciness (watermelon)
- Freedom from defects such as blemishes, mechanical injury, disorders, diseases and shrivel
- Nutrition ( see Table on next page)
Table 1. Nutrient value of raw Florida avocado fruit (3.5 oz or 100 g of fruit). (Crane et al., 2001)

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Approximate value</th>
<th>Constituent</th>
<th>Approximate value</th>
<th>Constituent</th>
<th>Approximate value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water content</td>
<td>80%</td>
<td>Carbohydrate</td>
<td>8.91 g</td>
<td>Phosphorus</td>
<td>39 mg</td>
</tr>
<tr>
<td>Calories</td>
<td>112 kcal</td>
<td>Total dietary fiber</td>
<td>5.3 g</td>
<td>Potassium</td>
<td>488 mg</td>
</tr>
<tr>
<td>Protein</td>
<td>1.59 g</td>
<td>Calcium</td>
<td>11 mg</td>
<td>Sodium</td>
<td>5 g</td>
</tr>
<tr>
<td>Fat</td>
<td>8.87 g</td>
<td>Iron</td>
<td>0.53 mg</td>
<td>Vitamin C</td>
<td>7.9 mg</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>0.0 mg</td>
<td>Magnesium</td>
<td>34 mg</td>
<td>Vitamin A</td>
<td>612 IU</td>
</tr>
</tbody>
</table>

**Horticultural Maturity**

Horticultural maturity marks the stage of development when the commodity possesses the quality parameters demanded by the consumer (green vs. ripe mango; pickling vs. slicing cucumbers).

**Ripening**

Ripening is the process in which fruits attain reasonable aesthetic and/or food quality. Fruits are classified into two groups, depending on the ripening pattern.

- Climacteric – upon completion of growth, these enter a distinct ripening phase that can continue after harvest (avocado, banana, mango, guava)
- Non-climacteric – must remain attached to the plant until ripe (lime, orange)

**Main Causes For Postharvest Loss**

- Mechanical injury has been determined to be the leading cause of quality loss at wholesale and retail levels for several crops. Injuries accelerate ripening, senescence (aging) and the growth of pathogens. Types of mechanical injury include bruising from impacts and compression, abrasion, cuts and punctures.
- Senescence due to ripening, moisture loss, decay.

**Harvest, Handling and Cooling Operations**

The goal of postharvest handling is to maintain quality while minimizing losses during the series of handling steps from harvest until consumer level. Postharvest losses can be minimized by careful harvest, timely transport to packinghouse, rapid cooling (precooling), consistent grading, packing into appropriate containers, and palletizing.

Avocado harvest dates are regulated by the Florida Avocado Administrative Committee [http://www.ams.usda.gov/FV/mocommodities/915.htm](http://www.ams.usda.gov/FV/mocommodities/915.htm). Harvest dates are set according to variety.
Avocados should be cooled to appropriate temperature (dependent upon type) as soon as possible after harvest. Proper cooling involves rapid removal of 7/8 of the field heat during the cooling operation. Hydrocooling is the most efficient cooling method, and under ideal conditions can remove field heat within 30 minutes. Forced-air cooling can also be used, although it is slower and may cause some moisture loss. The lowest safe storage temperatures are 54°F (13°C) for West Indian types and 40°F (4°C) for most other Florida varieties. Maintaining relative humidity at 85% to 90% will also reduce moisture loss during handling and shipping. Storage below these temperatures leads to development of chilling injury, which is characterized by a browning or darkening of the skin and/or grayish-brown discoloration of the flesh.

**Other Postharvest Treatments**

**Ethylene Pretreatment for Uniform Ripening**

A series of experiments were performed during the 1998-99 production season to determine the effects of postharvest application of ethylene gas on avocado ripening and fruit quality (Jeong et al., 1999). These preconditioning treatments were tested on early-season (‘Simmonds’), mid-season (‘Booth 7’) and late-season (‘Monroe’) varieties. Overall results indicated that avocados from preconditioning treatments ripened more uniformly and quickly than those from ungassed treatment (control). Although the peel of gassed fruits was significantly more yellow than that of ungassed fruits, the pulp of preconditioned fruits had acceptable appearance and was palatable. There were no significant differences in dry matter content or oil content of the pulp during fruit ripening due to gassing. It was not possible to estimate pulp oil content using dry matter content, due to wide variability of oil content between individual fruits.

From the tests with ‘Simmonds’ avocados, it was determined that fruits which were gassed immediately after harvest (100 ppm ethylene) had more uniform ripening and better pulp quality than fruit stored for several days prior to gassing. Accelerated ripening by gassing did not prevent chilling injury of fruit stored at 50°F and 53.5°F.

Tests with ‘Booth 7’ avocados revealed that best fruit quality was obtained with immediate preconditioning at 68°F for 12 hours. After subsequent storage at 54°F in air for 14 days, fruit from this treatment developed no chilling injury, remained acceptably firm and ripened normally. Gassing for 48 hours at 54 or 68°F, followed by ripening at 68°F caused pulp (mesocarp) browning, peel discoloration, non-uniform ripening and stem-end rot.

‘Monroe’ avocados preconditioned at 68°F for 12 hours, ripened more uniformly and quickly than those that were ungassed. After 14 days storage at 54°F and ripening at 68°F, fruit from this preconditioning treatment had no chilling injury and ripened normally while maintaining marketable fruit firmness.

**Delayed Ripening Pretreatment**

Several years of studies have culminated in the recent approval of SmartFresh™ (Agro-Fresh, Inc.) for application to fresh horticultural crops. SmartFresh (1-methylcyclopropene, or 1-MCP), has been shown to delay ripening and extend the postharvest shelf life and
quality of numerous fruits and vegetables. In particular, apple, tomato, and avocado fruits have shown remarkable results.

Avocado softening and loss of green color was delayed through the use of SmartFresh compared to untreated fruit (Huber et al., 2003). Application of 400 parts per billion for 12 hours delayed softening and ripening of ‘Simmonds’ avocado fruit (Figure 1), giving it nearly twice the time before reaching the full, ripe, edible stage. As shown in Figure 2, the external color of avocado fruit (shown after 6 days at 68°F) was maintained longer after exposure to 1-MCP.

Figure 1. Fruit firmness (N) of ‘Simmonds’ avocado fruit stored at 68°F following SmartFresh treatment (450 parts per billion, 68°F for 24 hours)

Figure 2. Simmonds avocado fruit 6 days (68°C) after treatment with SmartFresh (Huber et al., 2003)
References


